Ontario

Bass Stocking and Transfers: An Annotated Bibliography and Literature Review

Bass Stocking and Transfers: An Annotated Bibliography and Literature Review

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Preface

This bibliography and literature review is the fourth in a series of reference documents developed in conjunction with a review of fish stocking policies and guidelines for the Province of Ontario. It has been prepared to summarize information on the current state of knowledge regarding the stocking and transfer of bass (smallmouth and largemouth) in a form which can be readily utilized by field staff and stocking proponents.

Material cited in this bibliography includes papers published in scientific journals, magazines and periodicals as well as "gray" literature such as file reports from the Ministry of Natural Resources (MNR) field offices. Unpublished literature was obtained by soliciting information (i.e., unpublished data and file reports) from field biologists from across Ontario. The majority of the published information was obtained from a comprehensive literature search conducted in the MNR corporate library in Peterborough. Twenty-one major fisheries journals were reviewed as part of this exercise. These included: Aquaculture (1972-1998), California Fish and Game (1971-1999), Copeia (1913-1999), Environmental Biology of Fishes (1976-1999), Fishery Bulletin (1963-1999), Fisheries Management (1975-1984), Journal of Freshwater Ecology (1981-1999), New York Fish and Game Journal (1954-1985), North American Journal of Fisheries Management (1981-1999), Journal of the Fisheries Research Board of Canada/Canadian Journal of Fisheries and Aquatic Sciences (1950-1999), Progressive Fish Culturist (1940-1999), and Transactions of the American Fisheries Society (1929-1999). Material was also compiled from other journals such as the Journal of Wildlife Management, Fisheries, Sylva, Journal of Freshwater Fishing, Wisconsin Conservation Bulletin and Canadian Fish Culturist. Searches were also made of other publications including Proceedings of the Annual Meeting of the Southeastern Association of Fish and Wildlife Agencies, Proceedings of the Annual Meeting of the Western Association of Fish and Wildlife Agencies, Transactions of the Annual North American Fish and Wildlife Conference, Transactions of the Annual Midwest Fish and Wildlife Conference, United States Department of the Interior Fisheries Technical Papers, FAO Fisheries Technical Papers and Circulars, and reports published under the Canadian Technical Report Series of Fisheries and Aquatic Sciences. A search of the World Wide Web was conducted resulting in abstracts from papers presented at Division meetings of the American Fisheries Society as well as the 2000 Annual Meeting. Some information was acquired through a search of the Fish and Fisheries Worldwide Database (1971-present) via the Internet.

Included are over 590 citations, of which over 425 involve a synopsis or annotation. Many citations from State Departments and were not readily available for review. Abstracts from published papers have been included wherever possible. In cases where abstracts were unavailable, pertinent information from the document was extracted to provide a summary of the findings. Finally, in some cases, we were unable to acquire a copy of the document and have simply included the citation.

Table of Contents

Preface . . . . (i)

Table of Contents . . . . (ii)

History of Bass Stocking in Ontario 1

Synthesis of Selected Literature 5

Annotated Bibliography 25

Acknowledgements 191

Subject Key 193

Subject Index 195

Appendix 1. Largemouth bass stocking in Ontario waters, 1930-1999.

Appendix 2. Smallmouth bass stocking in Ontario waters, 1888-1999.

Appendix 3. Records of selected bass transfers and introductions in Ontario waters based on a 2000 survey of OMNR field staff.

Appendix 4. A summary of post-stocking survival rates of largemouth bass reported from various North American waters.

Appendix 5. A summary of post-stocking survival rates of smallmouth bass reported from various North American waters.

Appendix 6. Contribution of stocked largemouth bass to selected recreational fisheries in North America.

Appendix 7. Contribution of stocked smallmouth bass to selected recreational fisheries in North America.

History of Bass Stocking in Ontario

The smallmouth bass (*Micropterus dolomieu*) and the largemouth bass (*Micropterus salmoides*) are two of the most popular sportfish in North America. They are often referred to collectively as black bass and the distinction between the two species is not always apparent in early Ontario fisheries records.

The stocking of bass began primarily as the transfer of adult fish in the later part of the nineteenth century. The first recorded transplant by the federal government occurred in 1873 and transfers occurred irregularly into the 1900s. The early production of bass fry for stocking occurred in a federal hatchery. Bass were transferred and planted in response to public demand and stocking was seen initially as a cost-effective method of providing food for local fishermen while simultaneously ensuring recreation for tourists.

The first Canadian attempt at artificial smallmouth bass propagation occurred in 1872 at the Newcastle Hatchery (MacCrimmon 1967). In 1880, the Newcastle facility produced one million smallmouth bass fry which were distributed into inland lakes (Anonymous 1965). One of the earliest federal records of bass stocking concerned the Newcastle Hatchery, which distributed 50,000 fry to various Ontario waters in 1884. Attempts were made in 1888, at the same hatchery, to overwinter parent bass since pond-rearing was still in the experimental stages. In 1889, 30,000 black bass fry were planted into Howard Lake, 20,000 were planted into rearing ponds at Newcastle, while 30,000 went to a Mr. Thomas Elliott for personal stocking. The Newcastle Hatchery was in operation until 1914. The facility at Belleville (also known as the Bay of Quinte bass ponds), which reared smallmouth bass and supplied fry to various locations, operated from 1901-1913 (Ontario Ministry of Natural Resources 2000). During this time the hatchery supplied thousands of fry to nearby waterbodies, as well as sending a portion to other provinces (Anonymous 1903).

Records of largemouth bass transplants dated 1895 detail projects carried out by the federal Fisheries Department in conjunction with the Crown Lands Department of Ontario in the Kenora area of northwestern Ontario. Adult bass were removed from Brooks and Bass lakes as well as Lake of the Woods and 1,000 were planted into each of Otter, Flint, Sturgeon and Whitefish lakes. Three hundred fish were also placed into Rossland and Oster-Sound lakes. A further transfer of between two and three hundred fish was made to Lake Deception from the Nipigon River (Anonymous 1896). Some other early stocking projects involving smallmouth bass into Ontario waters are presented in Table 1.

Table 1. Historical stocking of smallmouth bass in selected Ontario waterbodies.

Year	Waterbody (County)	Life Stage	Number Stocked	Reference
1901	Muskoka Lake (Muskoka)	Unknown	1,205	Anonymous (1914)
1901	Lake Rosseau (Muskoka & Parry Sound)	Unknown	700	Anonymous (1914)
1901	Lake Joseph (Muskoka & Parry Sound)	Unknown	1,052	Anonymous (1914)
1901	Lake Couchiching (Simcoe & Ontario)	Unknown	436	Anonymous (1914)
1901	Stoney Lake (Peterborough)	Unknown	751	Anonymous (1914)

Table 1 (cont'd)

Year	Waterbody (County)	Life Stage	Number Stocked	Reference
1901	Lake Simcoe (Ontario, Simcoe & York)	Unknown	603	Anonymous (1914)
1901	Holland River (Simcoe & York)	Unknown	387	Anonymous (1914)
1901	Golden Lake (Renfrew)	Unknown	372	Anonymous (1914)
1901	Grand River (Haldimand)	Unknown	674	Anonymous (1914)
1902	Long Lake at Rat Portage (Kenora District)	Unknown	460	Anonymous (1914)
1902	Lake of Bays (Muskoka)	Unknown	500	Anonymous (1914)
1904	Balsam Lake (Victoria)	Unknown	400	Anonymous (1914)
1904	Lake Scugog (Ontario, Victoria & Durham)	Fingerlings	1,400	Anonymous (1914)
1905	Gull Lake (Muskoka)	Unknown	100	Anonymous (1914)
1906	River Nith (Brant)	Unknown	600	Anonymous (1914)
1908	Haliburton Lake (Haliburton)	Unknown	520	Anonymous (1914)
1909	Whiteman's Creek (Brant)	Fingerlings	200	Anonymous (1914)
1910	Pigeon Lake (Peterborough)	Fingerlings	3,000	Anonymous (1914)
1910	Sturgeon Lake (Victoria)	Fingerlings	4,000	Anonymous (1914)
1911	Big Rideau Lake (Lanark and Leeds)	Fingerlings	300	Rideau Lakes Fisheries Assessment Unit (Undated)
1911	Maitland River (Huron)	Fingerlings	2,000	Anonymous (1914)
1912	Cache Lake (Algonquin Park)	Fingerlings	10,000	Anonymous (1914)
1912	Loughboro and Collins lakes (Frontenac)	Fingerlings	2,000	Anonymous (1914)
1912	Kenogami Lake (Timiskaming District)	Fingerlings	5,000	Anonymous (1914)
1913	Charleston Lake (Leeds)	Fingerlings	5,000	Anonymous (1914)

The Ontario Department of Fisheries apparently was reluctant to give approval for transfers. Waters which were considered to have an over-abundance of bass were far from access points and once "discovered" by the public it was predicted these lakes too would suffer from overfishing, or there would be opposition to the bass removal by local residents (Anonymous 1901). Bass transplants proceeded with caution.

One of the major problems encountered in transplanting bass was the method of transportation. With the assistance of the Grand Trunk Railway bass movement was greatly facilitated. In addition to rail transport, cars made fish transportation safer and decreased the risk of fish mortality. In 1901, the first year of partnership between the both the Grand Trunk and Canadian Pacific (CPR) railways and the Ontario Fisheries Department, 9,481 adult bass were transferred into waters at eighteen different access points, and in 1903, forty rivers and lakes were stocked with 12,955 adult smallmouth bass (Anonymous 1904). The railways were responsible for a large portion of bass introductions made in the early 1900s (Dawson 1999).

Only a few years later, did the impact of bass removal on the donor lakes become a concern. Donor lakes were not unlimited and an alternative to transfers had to be considered. In 1905, there was an increased amount of effort put into the rearing of bass in hatchery ponds by the provincial Fisheries Department. This method allowed control over the size/age of fish at planting and would not deplete the resident stock from one waterbody for the gain of another. In 1909, the Ontario Game and Fisheries Department attempted to raise their own smallmouth bass fingerlings in a Brantford pond and the success of this early venture encouraged further bass culture activities (Anonymous 1910).

The first year of smallmouth bass culture produced 25,000 fingerlings from one pond and, over the next several years as more ponds were built at Brantford and the nearby Mount Pleasant Hatchery was constructed, that number rose to 500,000 (Anonymous 1915). These fingerlings were stocked into at least fifty inland lakes and rivers. Over the next three decades bass pond culture expanded to include Ingersoll Pond, White Lake Fish Culture Station and the Government Reformatory in Guelph. By 1939 there were five provincial smallmouth bass rearing stations in Ontario (see Table 2).

Table 2. The propagation of smallmouth and largemouth bass in Ontario at government hatcheries, 1872-1987. (From MacCrimmon et al. 1974)

Name	Years of Operation	Species of Bass	Known Year(s) of Bass Propagation
Newcastle	1865-1914	Smallmouth bass	1872
Belleville	1901-1913	Smallmouth bass	1901-1913
Mount Pleasant	1909-1962	Smallmouth bass	1909-1962
		Largemouth bass	1931-1962*
Ingersoll Ponds	1931-1962	Smallmouth bass	1931-1962
White Lake	1934-present	Smallmouth bass	1935-1978
		Largemouth bass	1950
Sandfield	1937-1987	Smallmouth bass	1937*-1987
Skeleton Lake	1938-1991	Smallmouth bass	1938*-1975
		Largemouth bass	1971-1972
Westport	1950-1985	Smallmouth bass	1950-1977
		Largemouth bass	1951-1982
Deer Lake	1939-1990	Largemouth bass	1973

*Certain dates were inferred based upon the first and last years of operation of the specific hatchery and the fish species reared at that hatchery.

The propagation of largemouth bass was initiated in 1931 at Mount Pleasant, and was deemed successful in its first year (Anonymous 1932). The rearing of this species continued on a smaller scale than that of the smallmouth bass. The Provincial Westport Fish Culture Station began rearing largemouth and smallmouth bass in 1950. The Mount Pleasant facility ceased operation in 1962 along with Ingersoll ponds due to the decrease in demand for smallmouth bass fry and fingerlings (Anonymous 1963).

The stocking of largemouth and smallmouth bass is presently much less common than one hundred years ago. Currently, no provincial hatcheries culture either bass species. The Sandfield hatchery, which began operation in 1937, stopped rearing smallmouth bass in the late 1980s.

Previous to this, the White Lake Station, which opened its ponds to smallmouth bass in 1933, discontinued stocking smallmouth bass in the late 1970s. The propagation of bass still occurs at many private facilities. As of December 1999, approximately 25 of the private hatcheries located in southcentral Ontario were rearing bass (Muschett 1999).

Transfers of bass are continuing in several areas of Ontario by both the Ministry of Natural Resources and external proponents under the Community Fisheries Involvement Program (CFIP). Bass populations are monitored with the intention of protecting both the donor and recipient lakes. Many transplants take place periodically to thin-out stunted, dense populations, while simultaneously supplementing that of another lake. As with all fish species, introductions are currently approached with extreme caution and seldom occur if there exist rehabilitation alternatives.

Synthesis of Selected Literature

This section will attempt to summarize selected stocking and transfer-related topics under the following categories:

1. Survival of stocked bass
2. Contributions of stocked bass to the fishery
3. Factors influencing stocking success
4. Potential impacts of stocked bass
5. Best management practices for bass stocking and transfers
6. Guidelines for stocking farm/private ponds
7. Stocking assessment

Survival of Stocked Bass

Post-stocking assessments have been conducted using various recovery methods to estimate the survival rate of stocked bass. Survival is typically reported as the number of fish caught in proportion to the number of fish planted. Results of post-stocking survival documented for largemouth and smallmouth bass appear in Appendices 4 and 5. Numerous methods of evaluation such as sport fishing records, rotenone sampling, electrofishing and seining have been used to determine survival. In cases where small ponds are used, draining is often an option. The lack of uniformity in stocking projects creates difficulties when comparing survival rates (Table 1). Generally survival rates are greatest for largemouth bass stocked in ponds, rather than lakes or rivers.

Table 1. A summary of post-stocking survival rates for largemouth bass reported from various North American jurisdictions.

	Reported Survival Rates	
Life Stage Stocked	Lakes	Ponds
Fry	-	50-90% (N = 4)
Fingerlings	0.13-34.5% (N = 5)	1.0-93% (N = 22)
Adults	4-11% (N = 1)	49.5% (N = 1)

There is a disproportionate amount of information available for the two species and this consequently prohibited the compilation of a similar chart for smallmouth bass. The large amount of data concerning largemouth bass stocking survival was due to the great number of pond stocking/rearing experiments which have been conducted. However, the limited data available for smallmouth bass survival did demonstrate that fingerlings planted into test ponds experienced poorer survival than those placed into a stream environment. The short-term survival of adults in lakes was also shown to vary considerably, depending on the characteristics of the water.

All life stages of largemouth bass are involved in lake and pond stocking. It is more common for smallmouth bass to be stocked in lakes and rivers than farm ponds. The stocking of bass fry in ponds is frequent because of the larger amount of control that can be exerted over their environment. Survival of the bass may be greater when stocked alone rather than if stocked with other established species (Brown 1952).

The vulnerability of a bass as it enters a foreign system depends on its size in relation to predators as well as its ability to forage. Boxrucker (1982_b) found that mortality levels within a single year class were greater (by 11%) among stocked largemouth bass who experienced little or no growth, as compared to those whose growth was considered intermediate or high. The biological and physical nature of the water into which smallmouth and largemouth bass are stocked appears to be the largest contributing factor influencing survival rate, and will be discussed in a subsequent section.

Contributions of Stocked Bass to the Fishery

Many largemouth and smallmouth bass stockings have involved transfers of adult and subadult fish from one body of water to another. Transfers of older life stages allow for the fish to quickly enter the creel. A creel survey is typically used to measure the contribution of the stocked bass to the fishery and may be reported as the ratio of stocked to native fish caught or as a percentage of the total catch. The survival of smallmouth bass through their first summer of life has been correlated with their contribution to the creel (Fleener et al. 1974). The contribution of stocked bass to the fishery may be measured over many years, although Buynak and Mitchell (1999) found that the number of introduced largemouth bass caught exhibited a substantial decline during the third year following the cessation of stocking.

The frequency with which a waterbody is stocked may influence capture rates. Smallmouth bass introduced a single time into Lake Texoma were producing 2.75 kg bass six years later (Gilliland et al. 1989). In contrast, some sites have required continuous stocking for the maintenance of a successful fishery. The contribution of stocked largemouth and smallmouth bass to the fishery in numerous North American waters is documented in Appendices 6 and 7. Results of assessment projects demonstrate returns to the fishery ranging from 0.2 to 91.5% for largemouth bass. It is difficult to compare these projects because of differential stocking procedures. There is also a large discrepancy between the Florida and northern strains of largemouth bass. The northern subspecies appears to be more easily caught than the Florida subspecies and, as such, their contribution to the fishery is greater.

The stocking of farm ponds for the purpose of recreational fishing is popular although unfortunately, little information is available as to the success of these fisheries.

Factors Influencing Stocking Success

The success of largemouth and smallmouth bass plantings vary for many reasons. The biological, physical and chemical characteristics of the water itself greatly influence post-stocking survival. Water quality parameters such as turbidity, temperatures and acidity can determine bass survival and their degree of adaptation to new waters. Predation and competition between the bass and native (or simultaneously stocked) species are likely to have a negative effect on stocked bass. The condition of the fish as it arrives in new waters, size at stocking, overall health and the conditions surrounding the stocking activities (transport, technique etc.) can dictate post-stocking success (see Table 2).

Table 2. Factors influencing the stocking success of largemouth and smallmouth bass.

Factor	References
Poor habitat and/or water quality	Anderson (1948), Anderson et al. (1971), Bowman (1993, 1994), Buynak (1985), Hebda et al. (1990), Henshall (1917), Holloway (1951), Hunt and Annett (1994), Kuehn (1982), Moorman (1956), Mraz (1954), Snucins and Shuter (1991), Tucker et al. (2000), Wurtz-Arlet (1953)
Age/size of fish when stocked	Anonymous (1910), Archambault et al. (1990), Brown (1952, 1961), Buynak (1985), Buynak and Mitchell (1999), Collins and Mitchell (1996), Copeland and Noble (1994), Heidinger (1976$_b$), McIntyre (1982), Ministère du Loisir, de la Chasse et de la Pêche (1988), Mitzner (1974), Moen (1960), Oliver et al. (1979), Redmond (1972), Satterfield and Flickinger (1986), Shiels and Jackson (1993), Smith and Reeves (1986)
Genetic strain	Addison and Spencer (1972), Childers (1975), Cichra et al. (1981), Forshage and Fries (1995), Fullerton et al. (2000), Gilliland (1994), Grant (1970), Inman et al. (1987), Isely et al. (1987), Johnson (1975), Kleinsasser et al. (1990), Philipp and Whitt (1991), Rieger et al. (1978), Smith and Wilson (1981), Wright and Wigtil (1981), Zolcynski and Davies (1976)
Stocking technique	Anonymous (undated$_b$, 1902, 1959), Buck and Hooe (1986), Buynak and Mitchell (1999), Buynak et al. (1999), Collins and Mitchell (1996), Dawson (1999), Dickson (undated), Dillard and Novinger (1975), Dyche (1913), Geishsler and Holder (1983), Fieldhouse (1971), Hunt and Annett (1994), Illinois Department of Natural Resources (1998), Johnson and MacCrimmon (1972), Krumholz (1952), Kuehn (1982), McIntyre (1982), Ministère du Loisir, de la Chasse et de la Pêche (1988), Neal et al. (2000), Ontario Ministry of Natural Resources (1989), Smith and Swingle (1943), Smith et al. (1975), Swingle (1945), Thurston (1978), Wisconsin Bureau of Fisheries Management and Habitat Protection (1999)
Species combinations stocked	Brown (1952), Ball (1952), Ball and Tait (1952), Bonneau and Conley (1972), Borgeson (1987), Brown (1951), Brown and Thoreson (1951), Clark (1952), Dickson (undated), Dyche (1913), Eipper and Regier (1962), Emig (1966$_a$), Hall (1958), Heidinger (1993), Hill (1999), Janisch (1976), Johnson and Graham (1978), Johnson and MacCrimmon (1972), Krumholz (1950, 1952), Meehean (1952), Moorman (1956), Powell (1975), Regier (1962, 1963$_b$, 1963$_c$), Rickett (1976), Shelley and Modde (1982), Smith et al. (1975), Smith and Swingle (1942), Stone and Modde (1982), Swingle (1949$_b$, 1951, 1952)
Handling and transport stress	Anonymous (1902), Carmichael (1984), Carmichael et al. (1983), Englehart (1977), Johnson (1975), Porak et al. (1994), Rawson (1937), Smith and Swingle (1943), Snow et al. (1978), Williamson and Carmichael (1987).
Diet conversion and starvation	Aldrich (1945), Anderson et al. (1971), Anonymous (undated$_a$, 1931), Applegate and Kruckenberg (1978), Baldwin (1926), Ball

... cont'd

Table 2 (cont'd)

Factor	References
Diet conversion and starvation (cont'd)	(1952), Bennett (1952), Bennett and Childers (1957), Bennett et al. (1989), Brunson and Robinette (1986), Colgan et al. (1986), Fullerton et al. (2000), Gilliland et al. (1989), Hearn (1977), Henshall (1917), Hickley et al. (1994), Janisch (1976), Johnson and Graham (1978), Kurten (2000), Moyle and Holzhauser (1978), Parmley et al. (1986), Rach and Bills (1989), Rogers (1968), Taub (1972)
Fish health and disease	Grant (1970), Johnson$_b$ (1996), Maitland and Price (1969), Porak et al. (2000), Szalai and Dick (1998)
Intraspecific competition	Dawson (1999), Fieldhouse (1971), Johnson and Hale (1977), Larimore (1954)
Interspecific competition	Anonymous (undated$_a$), Bennett and Childers (1957), Fruetel (1995), Griffiths (1939), Hebda et al. (1990), Johnson and Graham (1978), Kerr (1978), Kerr and Grant (2000$_a$, 2000$_b$), Krumholz (1950), Ontario Ministry of Natural Resources (1989), Rosebery (1950), Strickland (1985), Wurtz-Arlet (1953)
Predation	Baldwin (1947$_b$, 1980$_a$), Brunson and Robinette (1986), Miranda and Hubbard (1994), Rickett (1976), Swingle and Smith (1943)
Post-stocking movements	Brown (1961), Copeland and Noble (1994), Freud and Hartman (1999), Gilliland et al. (1989), Hughes and Douglas (1966), Jones et al. (2000), Larimore (1954)

Habitat and Water Quality – Physical and chemical characteristics of the waterbody can greatly effect the success of stocked bass. Tucker et al. (2000) found that water condition had a pronounced effect on largemouth bass survival, when 90% of those stocked in reservoir water died in contrast with 0% of those which were maintained in tap water. Henshall (1917) discovered smallmouth bass had a higher rate of success in waters which had a current, such as streams, whereas largemouth bass preferred ponds and lakes. Oligotrophic waters are often more suited for smallmouth bass, while eutrophic lakes are more suited to largemouth bass (Bowman 1994, Buynak 1985). High levels of turbidity can have a detrimental effect on the growth and spawning of largemouth bass (Moorman 1956, Mraz, 1954). The ideal water quality parameters for largemouth and smallmouth bass are summarized in Table 3.

Table 3. General habitat requirements for largemouth and smallmouth bass.

Parameter	Requirement
Largemouth bass	
Lake size	• Shallow, ponds > 0.1 surface ha
Lake substrate	• Muddy or gravel bottoms
Water depth	• < 6 m
Water temperatures	• 15-25°C optimal
Dissolved oxygen	• > 3.0 mgL^{-1}
pH	• 4.2-10.4

...cont'd

Table 3 (cont'd)

Parameter	Requirement
Largemouth bass	
Water velocity	Little if any current
Total alkalinity	$< 900\ \text{mgL}^{-1}$
Vegetation	Plants such as cattail, waterlily and pondweeds
Water clarity	Clarity must be slight to moderate
Smallmouth bass	
Water body size	> 40.5 surface ha (lakes), streams wider than 10.5 m
Water body description	Lakes: mesotrophic, clean, clear; Rivers/streams: mid-order, cool, clear, 50-75% pools
Water depth	> 6 m deep in lakes and reservoirs, > 1.2 m deep pools in streams/rivers
Water temperatures	Prefers 13-26°C
Dissolved oxygen	$> 6\ \text{mgL}^{-1}$
pH	Tolerates 5.7-9.0, prefers 7.9-8.1
Water velocity	< 0.2 m/sec
Vegetation	Minimal vegetation
Water clarity	< 25 JTU (low tolerance for turbidity)

Age and Size of Fish Stocked – Generally, the larger the fish stocked the more likely they will survive to a catchable size. There is limited data available comparing the stocking of various age groups of largemouth and smallmouth bass, however, it appears that success can be achieved through stocking various sizes of fish, and certain circumstances dictate which age/size of fish should be stocked. When predation is minimal small fingerlings and fry of both species can be planted with positive results (Collins and Mitchell 1996, Ministère du Loisir, de la Chasse et de la Pêche 1988). Smith and Reeves (1986) state that fingerlings are suitable for introductory, rehabilitation and enhancement stocking, while adults are only successful when used for introductory purposes. Adults give mixed results and do not always proliferate in newly stocked waters. McIntyre (1982) found that only one out of six lakes stocked with adult largemouth bass demonstrated a high degree of success in establishing populations. Experiments by Kuehn (1982) found that the planting of a broodstock is the quickest method with which to establish a largemouth bass population, while fry stocking gave positive results if executed shortly after ice-out. Larger fish may be better equipped to overwinter. Oliver et al. (1979) found that larger fingerlings were superior to smaller fingerling smallmouth bass in surviving low temperatures.

Genetic Strain – Although there undoubtedly exist genetic variations among largemouth and smallmouth bass stocks distributed throughout North America, emphasis will be placed upon the two subspecies of largemouth bass: Florida largemouth bass (*Micropterus salmoides floridanus*) and northern largemouth bass (*M. s. salmoides*). The success of stocking either of the subspecies is variable and is usually dependent upon location. One of the significant differences between the two bass is their ability to tolerate extreme temperatures. Childers (1975) found that Florida largemouth bass were not able to adjust to prolonged low temperatures and in such cases experienced a high rate of mortality. Northern largemouth bass, in contrast, are genetically accustomed to cooler water temperatures. Predictably, the success of planting these two strains of bass lies within the temperature regimes of the receiving waterbody. Forshage and Fries (1995) in Texas also discovered that Florida largemouth bass were less likely to survive if planted in older, larger reservoirs. In more northern states, the majority of pond research demonstrates the superiority of the northern largemouth in terms of growth (Johnson 1975, Kleinsasser et al. 1990, Philipp and Whitt 1991, Zolcynski and Davies 1976). The Florida strain can, however, thrive outside of its native range, given that California has had great success with this subspecies. On the southwest coast of the United States, this variety of bass experiences faster growth than the native northern ("California") largemouth bass (Grant 1970).

The relative catchability of the northern and Florida largemouth bass is also in dispute. While many studies show that there is no difference in susceptibility to angling between the two species (Inman et al. 1987, Wright and Wigtil 1981), others contest that there is a large difference, and have discovered that *M. floridanus* is significantly more difficult to catch (Kleinsasser et al. 1990, Rieger et al. 1978, Zolcynski and Davies 1976).

Stocking Technique – Stocking technique includes stocking densities and species combinations, handling and transportation practices, release techniques and the timing and frequency of stocking.

Supplemental planting of bass or their introduction into a waterbody already occupied by other species can differ from that which occurs when being stocked into barren waters. When bass are not being planted in conjunction with other species they are typically being placed into larger, public waters and thus their stocking rates are guided by provincial and state policies and/or guidelines (Table 4). In contrast, many multiple species stockings occur in small ponds. The most successful stocking combinations have been discovered through experimentation (Table 5).

Table 4. Bass stocking rates utilized by selected North American jurisdictions.

Waterbody	Stocking Density	Reference
Québec (smallmouth bass)	• < 10 cm: 100-250/ha when no predators. • > 10 cm: < 50/ha when small number of predators.	Ministère du Loisir, de la Chasse et de la Pêche (1988)
Ontario (smallmouth bass)	• Fry: 100/ha. • Juveniles and adults: 100-150/ha in lakes 50-450 ha in surface area. • Juveniles and adults: 1 fish for every 3 ha in lakes > 450 surface ha.	Ontario Ministry of Natural Resources (1989)
Illinois waters (largemouth bass)	• 2.0-2.9 inches: 75-100/acre (0.4 ha). • 3.0-3.4 inches: 60/acre. • 3.5-3.9 inches: 40/acre. • 4.0-4.9 inches: 20/acre. • 5.0+ inches: 10/acre for stocking new/rehabilitated waters and supplemental stocking.	Illinois Department of Natural Resources (1998)
Illinois waters (smallmouth bass)	• Fingerlings: 50-100/acre (0.4 ha) for new/rehabilitated waters.	Illinois Department of Natural Resources (1998)
Minnesota waters (largemouth bass)	• Brood stock: 1 pair/10 acres (0.4 ha) for stocking new waters. • Fingerlings: 50-100/acre for restocking.	Kuehn (1982)

... cont'd

Table 4 (cont'd)

Waterbody	Stocking Density	Reference
Wisconsin waters (largemouth and smallmouth bass)	• Large fingerlings up to 25/acre (0.4 ha). • Adults up to 5/acre. • 25,000/water maximum for rehabilitative purposes.	Wisconsin Bureau of Fisheries Management and Habitat Protection (1999)

Table 5. Largemouth bass stocking combinations and ratios from selected North American experiments.

Waterbody Location	Fish Stocked per acre (0.4 ha)	Results/Comments	Reference
Southern Ontario (ponds)	100 bass fingerlings + 25 bluegill adults	Successful	Johnson and MacCrimmon (1972)
Southern Ontario (ponds)	100 bass fingerlings + 200 golden shiner adults	Unsuccessful	Johnson and MacCrimmon (1972)
Southern Ontario (ponds)	100 bass fingerlings + 300 fathead minnows	Satisfactory/intermediate results	Johnson and MacCrimmon (1972)
Alabama (ponds)	Bass fingerlings + bluegill fingerlings	75% survival	Smith and Swingle (1942)
Alabama (ponds)	Bass fry + bluegill fingerlings	80-90% survival	Smith and Swingle (1942)
Alabama (ponds)	100 bass + 1,500 bluegills	High catch per acre	Swingle (1951)
Alabama (ponds)	100 bass + 1,000 bluegills	High poundage per acre	Swingle (1951)
Alabama (ponds)	100 bass fingerlings + 750 bluegills + 250 redear sunfish	Recommended for fertilized ponds by the Alabama Game and Fish Division	Smith et al. (1975)
Alabama (ponds)	2 pairs of adult bass + 5-10 pairs of adult bluegills	Recommended to achieve a balanced population	Smith et al. (1975)
California (ponds)	50 bass fingerlings + 500 bluegill fingerlings	Favourable results	Emig (1966_1)
California (ponds)	50 bass fingerlings + 6-8 adult redear sunfish fingerlings	Favourable results	Emig (1966_2)
Georgia (ponds)	30 bass fingerlings + 400 bluegill fingerlings (or 340 bluegills and 60 redear sunfish)	Recommended for unfertilized ponds	Dickson (undated)
Georgia (ponds)	100 bass fingerlings + 1,000 bluegill fingerlings (or 850	Recommended for fertilized ponds	Dickson (undated)

... cont'd

Table 5 (cont'd)

Waterbody Location	Fish Stocked per acre (0.4 ha)	Results/Comments	Reference
Georgia Ponds (cont'd)	bluegills and 150 redear sunfish)		
Indiana (ponds)	200 bass + 200 bluegills	Successful	Meehean (1952)
Iowa (ponds)	Bass-bluegill-bullhead (ratio of bluegill to bass varied from 4:1 to 25:1)	57.6% success rate	Moorman (1956)
Iowa (ponds)	70 1.5-inch largemouth bass + 750-1,000 bluegill fingerlings +100 2-inch channel catfish	Recommended rate	Hill (1999)
Kentucky (ponds)	100 bass fry + 50 adult bluegills	Recommended rate	Clark (1952)
Michigan (ponds)	100 bass fingerlings + 100 adult bluegills	Recommended rate	Ball (1952)
Michigan (ponds)	150 bass fingerlings + 10 adult bluegills	Recommended rate	Ball and Tait (1952)
Michigan	40 bass fingerlings + 640 bluegill fingerlings	Resulted in 50% survival	Borgeson (1987)
Michigan	30 bass fingerlings + 640 bluegill fingerlings + 200 northern pike fry	Resulted in 50% survival	Borgeson (1987)
Michigan	30 bass fingerlings + 400 bluegill fingerlings + 200 northern pike fry + 60 channel catfish fingerlings +0.2 crappie adults	Resulted in 50% survival	Borgeson (1987)
Montana (ponds)	100 bass + 500 bluegills	Recommended rate	Brown and Thoreson (1951)
New York (ponds)	100 bass fingerlings + 400 2.5-4.0-inch golden shiners	For coolwater and warmwater ponds	Eipper and Regier (1962)
New York (ponds)	100 bass fingerlings + 1,000 bluegill fingerlings	Warmwater ponds > 0.5 acre (0.2 ha) and weed controlled	Eipper and Regier (1962)
South Dakota (ponds)	Bass-black bullheads	Poor survival	Stone and Modde (1982)
Texas (ponds)	Bass-bluegill	83.3% survival	Brown (1952)
Texas (ponds)	Bass-black crappie	69.0% survival	Brown (1952)

The largemouth bass-bluegill stocking combination is generally the most popular and successful for farm ponds. The common stocking rate is 100 fingerling bass and 1,000 fingerling bluegills per surface acre (0.4 ha). This combination is most productive in the midwestern states (Shelley and Modde 1982) and variations on these densities appear across the United States and southern Ontario. Regier (1963$_b$) suggests that bass-bluegill stocking is most successful where the pond owner has control over the vegetation/weeds and in deep, large ponds where the surface temperature is greater than 80°F for many weeks each summer.

The stocking of golden shiners and largemouth bass has produced mixed results. Johnson and MacCrimmon (1972) obtained poor results because bass growth was very slow, whereas Swingle (1949$_b$) found that using golden shiners as forage gave high first and second year growth rates. In areas where bluegill tend to overrun ponds and inhibit largemouth bass production, golden shiners provide a viable alternative forage species. Regier (1963$_c$) discovered that, in contrast with bass-bluegill plantings, largemouth bass experienced lower natural mortality, increased growth rates and regular reproduction when stocked with shiners. Unfortunately, bass usually tend to eliminate the golden shiner population within a few years of the initial stocking.

Other species, such as fathead minnows, black bullheads, channel catfish, gizzard shad, redear sunfish and goldfish, have been stocked in combination with largemouth bass in ponds, to varying degrees of success.

The season of stocking appears to be crucial to the survival of stocked bass. Regardless of geographical location, bass are typically planted in the spring or in the fall. Hunt and Annett (1994) found that the survival of fall-planted largemouth bass fingerlings was three to four times higher than those planted in the spring. In contrast, Fieldhouse (1971) reported that fall-stocked yearlings in Nassau Lake, New York, provided poor returns to the fishery. In areas with cooler climates largemouth bass should be planted in early spring, following ice-out, to avoid anoxic conditions and increase their chance of survival (Anonymous 1959, Kuehn 1982). In Georgia, the common practice is to stock bream and bass fingerlings together in the fall, or exchange the bass fingerlings for spring fry (Dickson undated). There has also been success in Ontario with stocking bass fingerlings in the late summer then following up with a planting of forage fish in the late fall (Johnson and MacCrimmon 1972). Neal et al. (2000) strongly suggested that supplemental stocking take place during the off-season (between September and November) to avoid immediate harvesting of the fish. The ideal stocking season is not necessarily identical for each region of North America and it is likely that some degree of trial and error must occur in order to discover the most profitable stocking seasons.

There are few studies which evaluate different release techniques on the survival/condition of stocked bass. In the early 1900s, bass were dropped from railway cars when the train stopped at a trestle over suitable waters (Dawson 1999). Steamboats towing scows were also implemented in the distribution of fish over a waterbody (Anonymous 1902). Currently, many methods are used, such as deposition by helicopter and fixed wing aircraft, release from trucks directly into the water and transportation involving packsacks (Thurston 1978). It is unclear if these different methods of release affected the success of a particular stocking project.

The frequency with which a waterbody is stocked varies depending on the objective of the stocking project. Multiple stockings may be beneficial in that they can override poor results derived from a single stocking event. The Ministère du Loisir, de la Chasse et de la Pêche (1988) recommends stocking smallmouth bass for three consecutive years before performing an assessment. Along similar lines of reasoning Smith and Swingle (1943) advised that when planting largemouth bass fry in streams they should be stocked for two successive years. There is little evidence to support the usefulness of multiple plantings, with the exception of some fisheries which depend on continuous stocking to sustain their harvests. Buynak and Mitchell (1999) found that a stocking program carried out over five years contributed to the fishery (11.6% of legal harvest) yet did nothing to increase the total number of fish harvested. Yearly restocking is of no value in waterbodies which have already reached their maximum productive capacity. Swingle (1945) found that the annual restocking of a bass-bluegill pond did nothing to improve the quality of fishing.

Handling and Transport Stress – Porak et al. (1994) believed that handling stress was a key factor in cases of high mortality of stocked largemouth bass. The level of plasma glucose in smallmouth bass rose sharply following handling and transport, and many fish still hadn't recovered from this traumatic event five days later (Carmichael et al. 1983). It is essential that transportation and handling time be as short as possible to minimize these impacts. Snow et al. (1978) found that a shipment of largemouth bass fry in plastic bags resulted in a high survival rate to destination (87.5%), yet that proportion was drastically reduced when it came to survival to distributable size. There is evidence which suggests that the more artificial the method of bass rearing, the less negative the effect of handling and hauling. In experiments by Williamson and Carmichael (1987) artificially fed raceway-reared largemouth bass had significantly lower handling-related mortality rates than those pond-reared on natural foods. There also appears to be genetically determined reactions when dealing with the handling and hauling of largemouth bass. *M. s. floridanus* has been shown to have a greater chance at contracting disease and demonstrate a higher degree of aggression when handled than the northern subspecies (Johnson 1975).

Diet Conversion and Starvation – The diets of the largemouth and smallmouth bass do not differ greatly. Because bass are generally reared under "natural" (i.e., not raceway) conditions, much of the food they consume while in ponds is similar to what they would be feeding on in the wild (see Tables 6 and 7). In the case of the largemouth bass a wide variety of stocked predator-forage combinations have been experimented with, and in the wild these fish species may not necessarily be preferred as prey.

Table 6. Food items of stocked largemouth bass.

Food Item	Reference(s)
Aquatic and Terrestrial Insects	Applegate and Kruckenberg (1978), Henshall (1917), Hickley et al. (1994), Rogers (1968)
Crayfish	Bennett (1952), Henshall (1917), Hickley et al. (1994), Parmley et al. (1986), Rach and Bills (1989), Szalai and Dick (1998), Taub (1972)
Crustacea	Henshall (1917)
Zooplankton	Colgan et al. (1986), Kurten (2000), Parmley et al. (1986), Rogers (1968)
Frogs	Henshall (1917), Hickley et al. (1994)
Fish:	
Bluegills	Anderson (1948), Bennett (1952), Bonneau and Conley (1972), Brown (1951), Brunson and Robinette (1986), Janisch (1976), Moyle and Holzhauser (1978)

Cont'd

Table 6 (cont'd)

Food Item	Reference(s)
Redear sunfish	Ball (1952), Bonneau and Conley (1972), Brown (1951), Dickson (undated), Hall (1958), Krumholz (1950, 1952), Nail and Powell (1975), Regier (1962), Swingle (1949_a, 1952), Swingle and Smith (1943)
Green sunfish	Anderson (1948)
Yellow belly sunfish	Brown (1951)
Bluegill x green sunfish hybrid	Brunson and Robinette (1986)
Crappies	Aldrich (1945), Anonymous (undated_a), Brown (1951, 1952), Clark (1952), Dyche (1913)
Golden shiners	Aldrich (1949), Anonymous (1931_a), Ball (1952), Fieldhouse (1971), Johnson and MacCrimmon (1967), Kerr and Grant (2000_a), Pardue and Hester (1966), Regier (1963_a, 1963_c), Swingle (1949_b)
Fathead minnows	Applegate and Kruckenberg (1978), Davies (1974), Hearn (1977), Heidinger (1976_b), Heidinger and Brooks (2000), Janisch (1976), Johnson (1975), Johnson and MacCrimmon (1967), Pardue and Hester (1966), Smitherman (1975), Stone and Modde (1982)
"Minnows"	Anderson et al. (1971), Baldwin (1926), Ball (1952), Henshall (1917)
Goldfish	Janisch (1976), Johnson (1975)
Mississippi silverside	Moyle and Holzhauser (1978)
Sacramento blackfish	Moyle and Holzhauser (1978)
Gizzard shad	Janisch (1976), Swingle (1949_b).
Mosquitofish	Hall (1958), Pardue and Hester (1966), Swingle (1949_b)
Black bullhead	Stone and Modde (1982)
Channel catfish	Heidinger (1976_b)
Warmouth	Bennett (1952)
Cyprinids	Rivero (1936)
Rainbow trout	Kerr and Grant (2000_a)
Brown bullhead	Cross (1971)
Lake chubsuckers	Bennet and Childers (1966)
Threadfin shad	Powell (1975)

The insect diet of the young-of-year largemouth bass consists mainly of *Corixidae*, *Ephemeroptera*, *Notonectidae*, *Chironomidae* and *Odonata* (Applegate and Kruckenberg 1978) and piscivory may not be necessary for survival. The stocking of forage fish in ponds can cause problems such as the tendency of bluegills to overpopulate a waterbody. Competition for food also occurs between crappies and largemouth bass (Anonymous undated$_a$). Starvation conditions can occur, especially overwinter, which affect the survival of the fish.

Table 7. Food items of stocked smallmouth bass.

Food Item	Reference(s)
Aquatic insects	Bennett et al. (1989), Christie et al. (1972), Gilliland et al. (1989), Henshall (1917), Ontario Ministry of Natural Resources (1989), Somers (1986)
Crayfish	Bennett et al. (1989), Gilliland et al. (1989), Henshall (1917), Ontario Ministry of Natural Resources (1989)
Crustacea	Henshall (1917)
Zooplankton	Bennett et al. (1989)
Frogs	Henshall (1917), Ontario Ministry of Natural Resources (1989)
Leeches	Ontario Ministry of Natural Resources (1989)
Fish:	
"Minnows"	Anderson et al. (1971), Coble (1971), Henshall (1917)
Bluntnose minnows	Emig (1966$_b$)
Golden shiners	Anonymous (1931$_a$)
Pacific salmon	Bennett et al. (1989)
Steelhead	Bennett et al. (1989)
Yellow perch	Forney (1972)

Pond stocking may affect the feeding behaviour of smallmouth bass. Bennett and Childers (1957) discovered that, when stocked alone, they had a tendency to become surface feeders and thus took more easily to fly-fishing. Also, smallmouth bass transferred from lakes to ponds had higher food consumption and feeding efficiencies than those of the stream dwelling form of bass (Johnson and Graham 1978).

Fish Health and Disease – Poor pre-stocking health of bass will likely result in low survival rates and diseased fish may even contaminate native species in the waterbody. Porak et al. (2000) traced the poor health and high vulnerability to angling of planted largemouth bass to a liver disease. Although parasites seldom kill their hosts they can be detrimental to their health (Johnsonb 1996). Grant (1970) reported that largemouth bass did not reach their destination alive because of an extremely heavy parasite load. The stocking of largemouth bass has been blamed for the introduction of parasites into new geographical areas. Maitland and Price (1969) state that

North American bass brought *Urocleidus principalis* with them to the British Isles leading to widespread infection. In another case, *Proteocephalus ambloplitis* was introduced into Saskatchewan reservoirs through the release of infected fingerlings (Szalai and Dick 1998). Using hatchery-reared fish for planting purposes as opposed to transfers, minimizes the chance of transmitting disease and parasites from one area to another.

Intraspecific Competition – There is limited research available concerning intraspecific competition. Competition can exist, however, between introduced and native bass. It is well known that the introduction of bass into a population which is already self-sustaining will seldom be successful due to these interactions. Dawson (1999) concluded that supplemental stocking in waters of Ontario with established populations was a wasted effort.

Interspecific Competition – A number of other fish species are believed to compete with bass for food and space (Table 8). Smallmouth and largemouth bass are typically some of the larger and more aggressive of the fish species in the waters which they inhabit and, as a consequence, any direct competition that is experienced generally results in their favour. An exception to this is when bass are overwhelmed by the shear numbers of another species (e. g., bluegills or rockbass). The stocking of both largemouth bass and smallmouth bass in a small waterbody is not recommended as the largemouth outcompetes the smallmouth bass in the majority of cases (Johnson and Graham 1978).

Table 8. Competitors of stocked largemouth and smallmouth bass.

Fish species (Competitor)	Reference(s)
Crappie (largemouth)	Anonymous (undated$_a$), Rosebery (1950)
Channel Catfish (largemouth)	Rosebery (1950)
(smallmouth)	Griffiths (1939)
Bluegill (smallmouth)	Bennett and Childers (1957), Krumholz (1950)
Walleye (smallmouth)	Fruetel (1995), Ontario Ministry of Natural Resources (1989)
Brook trout (smallmouth)	Hebda et al. (1990), Kerr and Grant (2000$_b$), Strickland (1985)
Northern pike (smallmouth)	Ontario Ministry of Natural Resources (1989), Wurtz-Arlet (1953)
Yellow perch (smallmouth)	Ontario Ministry of Natural Resources (1989), Wurtz-Arlet (1953)
Rock bass (smallmouth)	Kerr and Grant (2000$_b$)

Largemouth bass and crappie compete for similar food sources and the level of competition may become especially intense in ponds (Anonymous undated$_a$, Rosebery 1950). Both the smallmouth and largemouth bass seek similar food resources (Griffiths 1939, Rosebery 1950). The rock bass and smallmouth bass also require similar spawning grounds and have similar feeding habits (Kerr and Grant 2000$_b$). Large populations of these smaller species can cause problems for introduced bass. It may be unproductive to stock either bass species in communities which already contain extensive populations of another top predator such as the walleye, sauger, yellow perch or northern pike (Ontario Ministry of Natural Resources 1989).

Predation – Cannibalism and predation is to be expected and should be considered along with stocking density when stocking ponds and making new introductions (see Table 9). Because a large amount of largemouth bass stocking occurs in easily controlled waters (i.e., ponds), there is usually no need to fear predation will be the cause of stocking failure, however, there exist reptilian, mammalian and avian species which prey on bass and a waterbody should be properly assessed prior to their introduction to determine the extent of predatory species.

Table 9. Predators of stocked largemouth and smallmouth bass.

Predator (Prey)	Reference(s)
Northern pike (smallmouth)	Baldwin (1947_b), Ontario Ministry of Natural Resources (1989), Wurtz-Arlet (1953)
Smallmouth bass (smallmouth)	Kerr and Grant (2000_b)
Brown bullheads (largemouth)	Baldwin (1980_a)
Bowfin (largemouth)	Baldwin (1980_a)
Muskellunge (largemouth)	Kerr and Grant (2000_a)
Largemouth bass (largemouth)	Brunson and Robinette (1986), Miranda and Hubbard (1994), Rickett (1976)
Bluegills (largemouth)	Swingle and Smith (1943)

Post-Stocking Movements – The extent of movement by largemouth and smallmouth bass can vary significantly. There generally occurs a greater amount of displacement in rivers than in lakes, and it is possible for bass to travel dozens of kilometres from the planting site. Since stocking sites are typically chosen for their suitable habitat, as well as their accessibility, it is not surprising that many fish remain close to their stocking site. Brown (1961) found that 100% of smallmouth bass stocked in an area of poor habitat moved greater than half of a mile away, compared with only 35.7% of those released in high quality habitat. More gradual movements can occur, such as the dispersal of bass over twelve kilometres during a period of six years in a lake (Gilliland et al. 1989).

There is evidence that tendencies to migrate from a stocking site may be environmentally induced. Larimore (1954) discovered that one year following the stocking of smallmouth bass into a stream, 75% of those who had been pond-reared were still occupying the same half of a mile of stream into which they were planted, in contrast with the bass transferred from another stream which subsequently had dispersed throughout the stream.

The stocking of fish into large rivers is ineffective unless they will remain near the site of stocking. Freud and Hartman (1999) found that planting largemouth bass into river embayments could contribute to returns to a fishery, if the fish remained in these protective areas.

Potential Impacts of Stocked Largemouth and Smallmouth bass

The introduction of smallmouth and largemouth bass can have a number of negative effects on the resident fish community (Table 10).

Table 10. Potential impacts of smallmouth and largemouth bass stocking.

Potential impact	Reference(s)
Predation on resident fish	Bennett et al. (1989), Brunson and Robinette (1986), Johnson and Hale (1977), Kerr and Grant (2000_a, 2000_b), Rivero (1936), Strickland (1985)
Competition/displacing other fish	Armstrong and Mackereth (2000), Buckmeier and Betsill (2000), Casselman and Betsill (2000), Catt (1949), Dawson (1999), Griffiths (1939), Kerr and Grant (2000_a, 2000_b), Page (1880), Vander Zanden and Rasmussen (2000), Wurtz-Arlet (1953)
Hybridization	Bottroff and Lembeck (1978), Buck and Hooe (1986), Bulak et al. (1995), Dunham et al. (1992), Gelwick et al. (1995), Goodman (1991), Kerr and Grant (2000_a, 2000_b), Morizot et al. (1991), Pelzman (1990), Whitmore (1983)
Disease transmission	Maitland and Price (1969), Kerr and Grant (2000_a, 2000_b), Szalai and Dick (1998)

Bass introductions have resulted in the transmission of diseases and parasites to wild populations. In one extreme case the introduction of largemouth bass into Cuban waters caused a rise in cases of human malaria which was attributed to bass preying upon the native species which fed upon mosquito larvae (Rivero 1936). Severely parasitized fish are generally poor in health and undesirable to the angler.

Largemouth bass have been blamed for decimating forage fish species such as fathead minnows and golden shiners (Kerr and Grant 2000_a). Smallmouth bass are believed to prey upon young walleye, thus decreasing the population of this native species (Johnson and Hale 1977). Smallmouth bass are also known for the displacement and disappearance of brook trout populations (Deyne and Tough 1995, Kerr and Grant 2000_b, Hebda et al. 1990, Strickland 1985). Both species compete for similar resources and habitat and in the majority of cases the smallmouth bass is predominant.

Stocked bass can also displace resident bass, as did largemouth bass fingerlings during a study by Buckmeier and Betsill (2000). Introductions can also have positive effects on other species. Prentice and Betsill (1997) found that small impoundments stocked with largemouth bass increased the growth rate of resident sunfish, probably because the increased predation caused to population to mature and grow faster.

The hybridization of largemouth bass has been a considerable problem in some areas of the United States. Northern and Florida subspecies have mixed to create bass which are not as tolerant of cold temperatures as the northern variety. This hybrid is enjoyed by many anglers in the southern United States since the Florida largemouth bass alleles generally contribute to a larger fish (Forshage and Fries 1995). The two species of black bass can also hybridize with each other. Research by Buck and Hooe (1986) found that growth by pure age-0 largemouth bass was greater than or equal to hybrids and therefore hybridization between these two species is undesirable. In the southern United States the smallmouth bass hybridizes easily with the Guadalupe bass and consequently only a few wild Guadalupe populations remain (Goodman 1991).

Best Management Practices for Bass Stocking and Transfers

Stocking and transfers of smallmouth bass have been more common than that of the largemouth bass in Ontario. Based on information reviewed, the following best management practices are presented for future bass stocking and/or transfer activities.

Stocking Objective – Prior to stocking a body of water it is essential that the motivation behind the stocking event be clearly identified. In the past, many stockings and transfers have been carried out with little thought as to the goals or consequences. It is important to justify the planting of largemouth and smallmouth bass. Lakes, rivers and reservoirs are likely to be stocked with bass to support a put-and-take sport fishery or to control large forage populations, while introductions are usually made to fill a gap in the food chain and establish a fishery in the future. Farm/private ponds are typically stocked with largemouth bass to provide recreation as well as a low-cost food source. There is also a need to establish quantified criteria in order to determine the success or failure of the stocking/transfer endeavour. The identification of these objectives will ultimately dictate the stocking techniques necessary to achieve the goals of the stocking project.

Supplemental Stocking – Stocking over a resident population has not proven its effectiveness at enhancing healthy, established bass populations. In the long term, fish stocked above the ecosystems carrying capacity will not contribute to the population. Supplemental stocking, when suitable, should be accomplished with the use of older fingerlings and adults (Smith and Reeves 1986). The larger the fish, the greater the ability to compete with those fish already in the system.

Waterbody Characteristics – Bass tend to adapt easily to a variety of waters and their health is only affected when exposed to extreme conditions. Even so, potential waters to be stocked should be given a complete water quality evaluation which takes into consideration chemical and physical properties as well as the productivity of the water. Both smallmouth and largemouth bass prefer mesotrophic waters, with the largemouth being more suited to eutrophic conditions. The level of turbidity is also an especially important factor, and levels must be low for both species. Physical features of lakes are also significant. The presence of gravel substrate is vital if a permanently established population is desired as it is ideal for spawning. Waters for smallmouth bass should have a high level of oxygen, while the largemouth bass can tolerate waters with less oxygen.

Strain of Fish – It is recognized that there exist numerous strains of bass. Of particular interest is the Florida subspecies of the largemouth bass, which is unsuitable for Ontario waters. It is genetically adapted to warm climates and the introgression of its genes with those of the northern subspecies is undesirable. The Florida strain of largemouth bass should not be introduced to Ontario waters. It is important when transplanting bass that the waters involved share common physical, biological and chemical characteristics. This practice should reduce the differences between the native and introduced populations and limit potential negative impacts of hybridization.

Disease Considerations – Fish introductions should be made taking precautions to prevent the spread of disease or parasites. A single infected individual could contaminate an entire native population. Hatchery-reared bass are generally more reliable in terms of health than those from natural areas and hatchery-reared fish should be used whenever possible to avoid the contamination of a waterbody. Largemouth bass should be randomly sampled for the helminth *Proteocephalus ambloplitis*, and the trematode *Urocleidus principalis* prior to planting. It is preferred that no fish at all be stocked as opposed to some which are suspect.

Age/Size of Fish to Stock – The size of bass to be stocked is dependent upon the stocking intentions and the biota already present in the aquatic system. Small fish (fry and 2-3 inch fingerlings) should not be planted where there is a threat of predation. Larger fish (6-8 inch fingerlings, yearlings, adults) should be stocked for put-and-take fisheries, while smaller fish may be acceptable for put-grow-and-take fisheries. When a fast growing bass population is necessary, yearlings should be reared and planted. The planting of fry or a brood stock is effective for introductory purposes, while enhancement stocking should involve large fingerlings.

Marking – There are numerous marking methods for fish identification, all with varying degrees of success. Fin clipping requires the least amount of effort, yet it is recommended that it be used only on older fish to avoid fin regeneration. Unfortunately, fluorescent pigment marking usually lasts no more than 6 months and tagging may have detrimental effects on the survival of the bass. Complete fin-removal offers permanence, but may affect survival. It is important to choose a marking system which corresponds with individual stocking assessment needs.

Stocking Rate – There is no single stocking rate which is suitable for all locations and all occasions. Recommendations vary with stocking objectives and the size of bass which is being stocked. Ontario Ministry of Natural Resources (1989) guidelines proposed the following rates for smallmouth bass stocking: fry = 100/ha, juveniles and adults in smaller lakes (50-450 ha in surface area) 100-150 in total, and juveniles and adults in larger lakes (> 450 ha) 1 fish/3 ha.

Stocking Frequency – Annual stockings should take place for 3 consecutive years when trying to establish a bass population in a new water. This should give the bass adequate opportunity to demonstrate their ability to colonize new territory. The stocking of bass can also occur periodically if it is suspected that a natural/established population is going to have a weak year class. Many heavily fished waters may require annual stocking. In some areas continued annual or biannual stocking may be necessary to maintain a desired population level.

Time of Stocking – To increase their chance of survival bass should be stocked at the time of year when there is ample oxygen and sufficient forage available to them. In northern regions, bass should be stocked following ice-out. Fall stocking, near turnover is also appropriate. For transfers, fry should be removed from the donor waterbody as close after swim-up as possible, when they are no longer under parental guard.

Transporting Fish to Stocking Site – In transporting bass it is essential that there be an adequate supply of oxygen. If shipment is to be made using plastic bags, a density of no more than 3,000 largemouth bass fry per litre of water is to be employed. During transfers, the donor lake should be used to supply the water used in transportation.

Release Sites – Habitat assessments of waters which are intended to be stocked should be made in order to determine the location(s) which would be most suitable for bass release. It has been noted that some bass tend to wander while others remain in a limited home range. Where a stream or river fishery is concerned the fish should be released as close as possible to areas frequented by anglers. Planting in inlets with suitable habitat will encourage the bass to remain close to the stocking site. Smallmouth bass should be distributed along rocky shores in no more than 3-4 feet of water, in the presence of cover such as logs or boulders. Largemouth bass should be placed on weedy, muddy bottoms with an assortment of available cover such as stumps, bolders or docks.

Stocking Technique – Stress is a threat to the health of fish, and therefore stocking success. Fish must be handled carefully and efforts must be made to keep the anxiety level of the bass as low as possible. A one percent salt solution may be used to reduce stress and injuries associated with handling.

Guidelines for Stocking Farm and Privately-owned Ponds

The specifics of pond-stocking vary from one area to the next. The following are general recommendations for (largemouth) bass stocking:

- Complete eradication of other fish species already present should occur prior to any bass stocking.
- The bluegill-largemouth bass combination most recommended is 1,000 bluegill fingerlings and 100 bass fingerlings per surface acre (400 and 40 per ha, respectively). An alternate ratio is 25 bluegill adults and 100 largemouth bass fingerlings (10 and 40 per ha, respectively). In unfertilized ponds, these numbers should be halved.
- If unavailable, other combinations such as largemouth bass and bluegills and redear sunfish, largemouth bass and bluegills and channel catfish, largemouth bass and golden shiners, and largemouth bass and fathead minnows are acceptable. Largemouth bass can also be planted alone and fed artificially.
- The forage species should be planted (if required) prior to the bass. It is a good idea to stock forage in the fall and largemouth bass in the spring.
- The pond should be a minimum of 0.5-acre (0.2 ha) and at least 8 feet deep, with proper spawning ground present.
- The pond should be approximately 90% free of aquatic vegetation.
- A drain outlet is beneficial.
- A fence surrounding the pond to prevent livestock access is essential.

Stocking Assessment

The evaluation of largemouth and smallmouth bass stocking projects may be carried out by a variety of methods. The precision of the chosen method typically depends upon the accuracy needed to establish the degree of stocking success. Comparisons should be made to previous stockings on regularly stocked waters. The actual evaluation may involve periods ranging from a few hours to many months, depending on the method used.

Existing netting techniques are valid stocking assessment methods. There are currently numerous netting protocols which can be used to evaluate stocking success such as nearshore community index netting (NSCIN) or early summer trap netting (ESTN).

Electrofishing is a common approach to quantifying the success of stocked bass. This can be performed at the site of stocking or at numerous areas in the stocked waterbody. The information collected is typically reported in terms of number of fish caught per-unit-of-effort. It is a useful method when determining the ratio of stocked to native fish.

Creel censuses are used when a determination of return to the fishery of the stocked bass is desired. The contribution of the fish in terms of catch-per-unit-effort (CPUE), ratio of stocked to unstocked fish, number of fish per hectare of water as well as many other values can be determined using a creel census.

In small water bodies, seining using an appropriate-sized net may capture a representative sample of the fish present and provide an accurate survival rate. Draining may also be an option in certain ponds or small lakes. This allows for each fish to be accounted for. In large waterbodies, such as rivers, rotenone sampling may be an option when executed at the stocking site.

There is a need for uniformity among, as well as within, assessment methods. There exists a great disparity between the periods of time a method implemented in conducting an adequate assessment. For example, gill-netting can occur for a few hours over two days, or ten hours a day over a month. As soon as uniformity is established it is hopeful that the results of fish stocking projects will be more easily compared with one another.

Annotated Bibliography

ADDISON, J. H. and S. L. SPENCER. 1972. Preliminary evaluation of three strains of largemouth bass (*Micropterus salmoides*) stocked in ponds in south Alabama. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 25(1971) : 366-374.

Seven ponds in South Alabama were stocked with Florida largemouth bass (*Micropterus salmoides floridanus*), seven with native largemouth bass (*M. s. salmoides*) and seven with F_1 bass. Samples of bass were collected one and two years after stocking to compare growth rates. Major objectives of this study were: to determine which of the three strains of bass grow faster and/or larger in Alabama ponds, to determine if *floridanus* can be successfully introduced into an established fish population of a 1,000 acre lake, and to compare the effectiveness of the three strains of bass in maintaining a balanced fish population.

All three strains of largemouth bass displayed rapid growth in ponds which did not contain a crowded bass population. The fastest growth observed was that of the F_1 bass. However, sufficient data has not been obtained in this study to fully evaluate the growth potential of the three strains of largemouth bass. Further evaluation is planned. The number of pyloric caeca proved to be the best single character for separation of the two subspecies of largemouth bass.

AGER, L. M. 1978. Evaluation of predator fish introductions into Lake Sinclair. Final Report, State Project WC-1. Georgia Department of Natural Resources, Game and Fish Division. Atlanta, Georgia. 41 p.

ALBERTA ENVIRONMENTAL PROTECTION. 1994. Alberta's fish stocking program. Fish and Wildlife Services Policy No. 40. Alberta Environmental Protection. Edmonton, Alberta. 17 p.

Currently the introduction of largemouth and smallmouth bass is discouraged for fear of negative ecological impacts which then add to the costs of fish culture. The stocking of species which are native to Alberta will be encouraged as an alternative.

ALDRICH, A. D. 1939. Results of seven years intensive stocking of Spavinaw Lake; an impounded reservoir. Transactions of the American Fisheries Society 68(1938) : 221-226.

The City of Tulsa, Oklahoma, operates a hatchery which has produced an annual crop of 400,000 fingerling fish, principally black bass, crappies and bream. Most of the fish have been planted in Spavinaw Lake, an impounded reservoir from which the City of Tulsa secures its water supply. The increase in the catch has not been in proportion to the number of fish planted. Many anglers still make poor catches. Studies of the lake show that bass are plentiful but hard to catch. Studies made at the municipal hatchery demonstrate that the intelligence of bass has been grossly underestimated. Additional evidence was also obtained by the catch records from a group of experienced fishermen. Expert anglers who know the lake and the habits of bass always make good catches.

ALDRICH, A. D. 1943. Natural production of pondfish in waters near Tulsa, Oklahoma. Proceedings of the Annual North American Wildlife Conference 8 : 163-168.

The weight of fish that a given pond will produce remains surprisingly stable one year after the next unless stocking methods are drastically altered. The size of the fish produced depends entirely on the number of fish in the pond. For example, Pond No. 17 was stocked with 40,000 bass fry and six months later produced 31,000 three-inch fingerlings. When stocked with 20,000 bass fry, the same pond produced 15,000 six-inch bass in 6 months.

Crappies and bluegills were allowed to flow into Pond No. 17 by using a drift method which allows supply water to bypass the brooder pond and go through the rearing pond. Once in the bass-rearing pond they provided additional food for the bass. Using this rearing-stocking method, 16,000 six-inch bass, 3,600 five-inch crappie and 4,250 two-inch bluegills were produced.

ALDRICH, A. D. 1949. Progress report: Improvement of fish-cultural practices in Oklahoma. Progressive Fish Culturist 11(1) : 25-29.

This project was an attempt to demonstrate various methods of pond operation and treatment for the production of desirable fish for stocking purposes, also to provide specific information which might be applicable to other waters and easily understood by pond owners.

Eight ponds at the Holdenville Fish Hatchery were selected for treatment and control. The experimental ponds were stocked with various combinations of fishes. The studies indicate that by fertilization the turbid waters of small lakes up to 10 feet in depth can be economically cleared and made highly productive of plankton organisms.

The increase of fish production, as expressed in pounds per surface acre, was very pronounced in the treated ponds. The highest yield, 421 pounds per acre, was obtained with the combination of bluegills and golden shiners. The next highest production, 280 pounds per acre, resulted from a combination of bass and golden shiners, where the bass were nearly all of legal length. Black bass, bluegills, and golden shiners in combination yielded high production and a large percentage of legal-length bass. Bass, crappie and bluegills when combined gave adequate production per acre, but the bass were small in comparison the to other ponds, averaging 100 per pound.

In order to grow black bass of legal length in one growing season, it is recommended that the ponds be stocked with advanced fry equal to 2,500 or less per acre.

ALOO, P. A. 1988. Studies of the ecology of the black bass (*Micropterus salmoides*) in Lake Naivasha, Kenya. M. Sc. Thesis, University of Nairobi. Nairobi, Kenya.

ANDERSON, J. K. 1966. Fish stocking. Dingell-Johnson Project KY F-26-R-1, Job D. Kentucky Department of Fish and Wildlife Resources. Frankfort, Kentucky. 4 p.

ANDERSON, R. O. 1971. Stocking strategies for warmwater fishes in lentic environments. p. 37-48 *In* R. J. Muncy and R. V. Bulkely [eds.]. Proceedings of the Northcentral Warmwater Fish Culture and Management Workshop, Iowa Cooperative Fisheries Unit, January 21-22, 1971, Ames, Iowa.

ANDERSON, R. O., H. S. MOHLER and G. DIVINE. 1971. Growth and survival of different geographic stocks of smallmouth bass in ponds in Missouri. *In* R. J. Muncy and R. V. Bulkley [eds.]. Proceedings of the Northcentral Warm Water Fish Culture

and Management Workshop, Iowa Cooperative Fisheries Unit, January 21-22, 1971, Ames, Iowa.

Two studies were conducted to compare smallmouth bass from a lentic and lotic environment. The productive performance was evaluated in terms of food consumption and utilization, growth, survival, recruitment of young and vulnerability to angling. An objective was to assess the feasibility of stocking smallmouth bass in ponds.

Progeny were utilized from adult stock from Green Lake, Minnesota, and from the Elk River and a tributary of the Current River in Missouri. Seasonal growth and rate of feeding of Green Lake and Elk River were compared by providing minnows *ad libitum* for individual yearling fish held in cages in a pond during the growing season in 1965. Growth, survival and angling vulnerability of the Green Lake and Current River smallmouth were compared by stocking six ponds in July, 1965, with young-of-the-year of both races, each marked by a different fin clip (left or right pectoral). The populations were checked by seining and angling from 1966 to 1969.

Mean annual length increment of the lake smallmouth bass (15.9 cm) was significantly different than that of Elk River stock (8.3 cm) in the cages. Both groups exhibited a dichotomous growth pattern with an early peak during late summer and early fall. The lake smallmouth consumed food at a higher rate, used it more efficiently for growth and exhibited a higher length-weight relationship than that of the Elk River fish.

In the pond stocking experiment Green Lake smallmouth bass had a greater growth rate, higher survival rate to age II and greater vulnerability to angling than the Current River stock. Growth of all bass varied among ponds and appeared to be inversely related to clay turbidity. Average total length of lake smallmouth in the fall at age I was 210 mm in a pond with an average Secchi disk of 15 cm and 277 mm in a pond where the average reading was 25 cm and 306 to 343 mm in ponds with an average Secchi disk of more than 60 cm. Recruitment of young bass to the populations occurred only in the two clearest ponds.

The results of these studies indicate that there are inherent differences between stocks from a northern lake and Missouri streams. The differences may be related to factors of natural selection that are different in lotic and lentic environments. The northern lake stock has the potential for good growth and production in some Missouri ponds.

ANDERSON, W. L. 1948. Results of an analysis of farm ponds in the Midwest. Progressive Fish Culturist 10(3) : 111-116.

Approximately 5,000 farm ponds have been stocked with fish by farmers cooperating with the Midwest Soil Conservation Service districts in the past 7 years. Current stocking techniques have been used based on research by Swingle and Smith in Alabama. To see if the recommendations were working out satisfactorily in the Midwest a survey was conducted of Ohio, Indiana, Illinois, Missouri and Iowa ponds.

Seine work was completed to check whether or not ponds previously stocked with the largemouth bass-bluegill combination were in balance. Pond status was verified through the use of a minnow seine. Pond condition was separated into three categories:

1) A pond was considered in balance if the seine contained both young-of-the-year bluegills and bass, plus a few bluegills measuring 2 to 3 inches in length.
2) A pond was found to be overcrowded with bluegills if the seine enclosed no young bass or bluegills and many 2- to 3-inch bluegills.
3) A pond was said to be overcrowded with bass if the seine contained only young-of-the-year bluegills.

The study indicated four main reasons for the failure of bass-bluegill ponds which were apparently stocked in keeping with Swingle and Smith, yet did not provide satisfactory fishing conditions:

1) When ponds are less than one-quarter of an acre, the planted bass will have a difficult time keeping the bluegill population under control, so it is recommended that ponds do not exceed a 0.25 acre minimum.
2) Many ponds became flooded by watersheds which were especially large for the pond size. This situation led to flooding of the ponds and excess siltation. Ten acres of water is recommended as sufficient to supply water to a pond up to two acres in surface area.
3) Stocking was not done as carefully as possible. In certain situations the hatchery had provided the pond owners with inadequate forage fish for the stocked bass, such as substituting green sunfish for bluegills. Also, the farmer may have delayed the entry of fish into the pond, thus decreasing their chance at survival.
4) Extreme weed growth contributed to systems with too many bluegills by providing extra shelter from the bass.

These four events are to be avoided as much as possible if a successful bass-bluegill stocked farm pond is to result.

This report has been presented to inform fishery biologists of the pond research which is ongoing in the Midwest. Ponds may become a very significant source of food for the people of this nation. Present-day research can lay the foundation for better pond management tomorrow.

ANNETT, C. A. and C. F. BAILY. 1994. Survival and sources of mortality in supplementally-stocked largemouth bass. Dingell-Johnson Project AR F-54-R-2, Studies I, II, III & IIIb, Final Report. Arkansas Game and Fish Commission. Little Rock, Arkansas. 120 p.

Objectives were to: (1) review records from the Arkansas Fish and Game Commission's Standardized Sampling Procedures to determine if patterns exist among lakes that regularly require supplemental stocking, especially with respect to success of stocking events; and (2) to select four impoundments (Lake Cargile, Lake Des Arc, Lake Sugarloaf, Lake Wedington) to be used for mark-recapture studies of survival and growth of supplementally-stocked largemouth bass in Arkansas.

ANONYMOUS. Undated$_a$. Summary of the major studies conducted in the Huron District: Farm ponds and productivity. Ontario Department of Lands and Forests. Hespeler, Ontario.

Using results from the United States one can attempt to predict the outcome of farm pond stocking. Black's Pond was chosen as a site for experimental fish planting and its characteristics appeared to mesh with those suitable for a bass population. The pond is 3 acres in area with a maximum depth of 8 feet. Species present in the pond include chubs, dace, crayfish and sticklebacks. It was decided that crappies should be stocked with the bass. On May 19, 1952, seven largemouth black bass and 12 black crappies were stocked into the pond. The pond was then seined on August 14, 1952, and some young largemouth bass were removed along with one young crappie. Although nests were not found, spawning had apparently taken place. The downside of using this bass-crappie combination was the fact that both species were in competition for the same food items.

ANONYMOUS. Undated$_b$. Smallmouth bass. http://www.lakecuyamaca.org/smallmou.htm.

Cuyamaca Lake is a 110-acre body of water situated in the San Diego, California region. In the fall of 1995 fifteen one to three pound smallmouth bass were introduced to the lake by the California Department of Fish and Game. Another stocking of fifty bass was made in 1997 using fish transplanted from another lake. The majority of the brood stock have been caught numerous times by anglers since their introduction, yet are still protected by a zero fishing limit to ensure propagation of the species. There already exists established populations of Florida largemouth bass, but it is hoped that this species will be more ideally suited to the cool water temperatures.

ANONYMOUS. Undated$_c$. Fish management and the creel census in Algonquin Park. Harkness File Report. Ontario Department of Lands and Forests. Whitney, Ontario. 7 p.

The smallmouth black bass first entered Algonquin Park near the beginning of the century. It is now found in the Petawawa system as far north as Lake Traverse. The Fish and Wildlife Department have already undertaken bass transplanting projects where fish are removed from crowded, stunted, populations and placed into waterbodies with weak, non-reproductive populations in the hopes of improving the fisheries for both the donor and recipient lakes.

ANONYMOUS. Undated$_d$. Grippen Lake survey. Ontario Ministry of Natural Resources. Kemptville, Ontario.

It is recommended that any plantings of smallmouth and largemouth bass be done only in small quantities. While there appears to be a few suitable sites for largemouth bass spawning the food supply is not sufficient. Marl deposits along the shoreline rock and shoals are also making for progressively worse smallmouth bass conditions.

ANONYMOUS. Undated$_e$. Lindsay District history of fish plantings in the Kawartha lakes. Ontario Department of Lands and Forests. Lindsay, Ontario. 2 p.

There are records of seven species being planted in the ten lakes considered, among them the smallmouth and largemouth bass. Many stockings occurred only once, whereas others were carried out over the course of a few years.

Chemong, Clear, and Stoney lakes were stocked only once with largemouth bass, with 750 fingerlings (1930), 690 fingerlings (1939) and 497 adults or yearling fish (1939), respectively. Plantings of the largemouth bass have occurred many times in Rice Lake, dating back at least as far as 1936. Balsam, Cameron, Pigeon and Sturgeon lakes first received bass in 1942. All plantings prior ro 1952 were of fry and fingerlings. Since that time many adult fish have been placed in Pigeon and Sturgeon lakes as part of the Nogies Creek fall netting project.

Stoney Lake was first planted with smallmouth bass in 1901 (751 fingerlings) and the majority of the Kawartha lakes had been stocked by 1921. Adult fish were first used in 1919 in Clear and Stoney lakes. No fry have been planted in either lake since 1954.

ANONYMOUS. 1896. Transplanting large-mouthed black bass. p. 202 *In* 28th Annual Report of the Department of Marine and Fisheries 1895: Fisheries. Ottawa, Ontario.

Working with the Crown Lands Department, adult black bass were transplanted from one lake to another. The majority of the fish were taken from Brooks Lake, situated between Otter Lake and Lake Rowan, Bass Lake and Lake of the Woods. One thousand individuals were planted into Otter, Sturgeon, Flint and Whitefish lakes, while 300 were introduced into Rossland and Oster-Sound lakes.

ANONYMOUS. 1897. Pennsylvania Fish Commission Board Report #18 of the State Commissioners of Fisheries for the Year 1896. Harrisburg, Pennsylvania. p. 154.

For the past twenty years the Pennsylvania Fish Commission has been stocking lakes and rivers with fish. Prior to the authorization of the Commission, individuals were planting black bass into the lakes for fishing purposes. However, when the Commission undertook this practice the interest in black bass flourished. During the existence of the Board small-mouthed and large-mouthed black bass were two of the most commonly planted fish into lake waters. The small-mouthed black bass has achieved the highest degree of success in mountain lakes as it easily adapts to new surroundings. It's only requirement is that the receiving waters be moderately pure.

ANONYMOUS. 1901. The Second Annual Report of the Department of Fisheries of the Province of Ontario, 1900. Toronto, Ontario. p. 12-13.

It has been suggested that many of the lakes situated in areas with low population levels could be used as sources for black bass. This procedure is looked upon unfavourably by the Department. There is concern that these lakes could become hot fishing spots if it was known to the public that they were abundant in bass or there could be an outcry from local people once they realize that their fish are being removed. Many of these lakes are also far from access points and capture and transport of the bass would likely be expensive. If this removal-stocking technique were to be used the bass would have to be removed in the spring, prior to any warm weather or captured in the fall, prior to spawning.

ANONYMOUS. 1902. Report of the Ontario Deputy Commissioner of Fisheries, 1901. Toronto, Ontario. p. 31-32, 75-79.

Continuing the work from last year, black bass are still being transplanted from lakes with large populations to areas where the numbers are little or non-existent. A large portion of the fish were deposited in the Muskoka and Kawartha Lakes, which are heavily fished, as well as Lake of Bays, which is quickly becoming a tourist attraction. In the future it is possible that plants will be made in rivers which travel through agricultural districts as they appear well suited for bass introduction. The purchase of 50,000 bass fry resulted in them being distributed to waters in the western part of Ontario, including the Thames.

Re-stocking the inland waters of Ontario with black bass is a fairly recent undertaking. According to records, the Dominion Government has been transplanting black bass since 1873, and the stocking has continued erratically since that time. There is now a call for greater introduction of the black bass. The majority of the inland waters of Ontario are suited for introduction, with the exception of waters containing brook trout habitat. The preferred method is the transference of the parent fish. When fry are used they should be planted before the disappearance of their yolk sac or as soon as they begin to feed.

Black bass are typically stocked in waterbodies which lie in close proximity to railway points for efficient transportation. The rate of survival during transportation is quite high. Eight hundred and fifty have been carried for 400 miles with only a 10% death rate and 720 were carried 225 miles with less than a 2% death rate. The most convenient way to distribute the fish into and around a lake is by use of a scow towed by a steamboat. The success rate has been high. Lakes which were planted with black bass prior to the establishment of the Department are now teeming with fish.

ANONYMOUS. 1903. The Thirty-fifth Annual Report of the Department of Marine and Fisheries, 1902. Ottawa, Ontario. p. 235-236.

The bass pond at the Bay of Quinte (Belleville) has produced fry to be shipped to Manitoba and the Northwest Territories, as well as local Ontario waters. Mature fish (brood stock) were also released out of province. These fish were transported a total of 2,300 miles, yet mortality did not exceed 10%. Mortality may have been lower, except for 1,100 miles it was impossible to obtain any fresh water.

ANONYMOUS. 1904. Report of the Ontario Deputy Commissioner of Fisheries, 1903. Toronto, Ontario. p. 10-12, 36.

Deposits of black bass have been made in at least twenty-five inland Ontario lakes. During the past summer over 4,000 fish were stocked into Lakes Muskoka, Joseph and Rosseau and are now reported to be teeming with small bass. Parent fish can be transported almost any distance as was demonstrated by the transplant of fish to the vicinity of Lake of the Woods by car.

Recently, the Grand Trunk Railroad has assisted in the transportation of black bass and during the first year (1901) 9,481 adult bass were distributed among 18 different points along the railway. By the end of last season almost 32,367 fish in total had been deposited (12,955 in that year) in forty different lakes and rivers.

ANONYMOUS. 1906. Report of the Commissioner of Fisheries. p. 1-28 *In* Report of the Commissioner of Fisheries for the Fiscal Year 1906 and Special Papers. United States Bureau of Fisheries. Washington, D. C.

From a partial list of fish species stocked in the United States by the U. S. Bureau of Fisheries in 1906, it was reported that 195,596 smallmouth bass (*Micropterus dolomieu*) (including eggs, fry, fingerlings, yearlings and adults) where planted into U. S. waters. The figure given for largemouth bass (*Huro salmoides*) was a bit different as it includes bass which were shipped to hatchery facilities in Massachusetts, Pennsylvania and Rhode Island. A total of 524,572 largemouth bass were distributed by the United States Bureau of Fisheries.

ANONYMOUS. 1910. Third Annual Report of the Ontario Game and Fisheries Department, 1909. Toronto, Ontario. p. 6-7.

For the first time the Game and Fisheries Department attempted to raise their own smallmouth bass fingerlings at a pond in Brantford. The results were tremendous and at least 25,000 of these fingerlings were planted in various areas of Ontario. The plantings were successful and recipient lakes showed high numbers of smallmouth bass. The expansion of bass pond culture will allow the re-stocking of lakes depleted by recent tourists and early settlers who had no regard for resource conservation. Ideally, stocking will also occur in waters that were never noted for their fishing importance, but which have the potential to become productive.

ANONYMOUS. 1911. Fourth Annual Report of the Ontario Game and Fisheries Department, 1910. Toronto, Ontario. p. 7.

In persisting with pond culture at Brantford, 50,000 bass fingerlings were planted into various inland Ontario lakes, located within minimal distance of the railway for transportation purposes. If past years are any indication the stockings should provide fishing opportunities for anglers and thousands of tourists.

ANONYMOUS. 1912. Fifth Annual Report of the Ontario Game and Fisheries Department, 1911. Toronto, Ontario. p. 7-8.

The bass-rearing ponds were established one year ago at Mount Pleasant and they have demonstrated a great level of success. Approximately 100,000 small-mouthed black bass were raised and distributed in numerous Ontario lakes. Although, there are no numbers available as of yet, it is expected that these bass will greatly improve bass fisheries for tourists and local fishermen.

ANONYMOUS. 1914. Seventh Annual Report of the Ontario Game and Fisheries Department, 1913. Toronto, Ontario. p. 119-123.

Ontario waters which were stocked with black bass (smallmouth) between 1901 and 1913 are given.

ANONYMOUS. 1915. Report Upon the Game and Fisheries Commission of Ontario for 1914. Toronto, Ontario. p. 72.

In the fifth year of operation the total number of smallmouth bass fingerlings raised at the Mount Pleasant Hatchery totalled 500,000. These were stocked into fifty inland lakes and rivers and the number lost during transportation was negligible.

ANONYMOUS. 1930$_a$. The black bass. p. 88-97 *In* The Twenty-Third Annual Report of the Game and Fisheries Department, 1929. Sessional Paper No. 36, Legislative Assembly of Ontario. Toronto, Ontario.

The smallmouth bass is generally the species under discussion, however the majority of culture and restocking considerations which arise apply equally to largemouth bass. Currently there are two areas reported in which restocking with largemouth bass is necessary: the Rideau System and the Niagara Peninsula. It is likely that many other waters are already depleted. The importance of bass to fishing is widely recognized and at the same time blamed for the depletion of these species. If control methods are not implemented quickly the smallmouth bass is marked for early extinction. Those methods which are generally applied include:

- Artificial or semi-natural propagation by the pond nesting process, followed by planting with advanced fingerlings or young bass;
- Distribution of pond grown older or adult bass;
- Distribution of wild bass from lakes or sanctuaries;
- Closure of the bass fishery.

With specific reference to artificial propagation it is well known that the typical method of stripping and hatching eggs in trays is not applicable. Bass nest and spawn intermittently. Special ponds must be constructed for a brood stock so that it may spawn and rear its young. Pond nesting and other methods of handling bass have been in practice in Ontario for upwards of thirty years. Between 1900 and 1910 the Dominion Government and the Province were involved in the transfer of adult bass for the re-stocking of Ontario waters. In 1908-1909 the Province attempted to produce bass under semi-controlled conditions and in 1909, 20,000 fingerlings were distributed. This demonstrated that in southern Ontario wild bass could be transplanted to a pond, hatch viable eggs and ultimately turn out thousands of offspring.

It is predicted that for the amount of re-stocking which needs to take place in this province, at least four sets of hatchery ponds (three for smallmouth and one for largemouth bass), consisting of six to eight individual ponds each, is needed to rear fish.

Culture practice now favours rearing fish to the greatest size possible in order to increase post-stocking survival. The use of fry has been found to be largely unsuccessful. When re-stocking with adults it is likely that the province will continue to rely upon wild stocks. The transfer of adult bass for general re-stocking appears to have been successful in many cases. The utilization of any source of wild bass, for re-stocking depleted waters, is worth some consideration. In many cases the natural hatchings in some lakes could be used as a supply of fry, which could then be reared in ponds.

There has been much discussion surrounding the complete closure of some bass fisheries. It has been suggested that stocking may be more effectual if the waterbody in question was closed to fishing for some time following the stocking.

Currently, there appears no one solution to the problem of decreasing numbers of bass and it is likely that many management practices will need to be implemented in order to reverse the this trend of early bass extinction.

ANONYMOUS. 1930$_b$. Report Upon the Game and Fisheries Commission of Ontario for 1929. Toronto, Ontario. p. 24.

The rearing of bass in large hatchery ponds, stocked originally with brood stock, is easily accomplished when the fish must only be kept to the fry stage. For rearing to the advanced fingerling and yearling stage abundant natural food is required and the cost of constructing these larger ponds is great. At present fingerlings and yearlings are being removed from certain bass lakes and being placed into lakes which are lacking. It is likely that these lakes serving as the donor waters will have to be closed to the public in order for total depletion to be avoided.

ANONYMOUS. 1931$_a$. Ontario Department of Game and Fisheries Annual Report, 1930. Toronto, Ontario. p. 43-49.

Restocking depleted waters with small-mouthed black bass must be viewed from many angles, particularly on account of the large extent of the waters with which we have to deal. Natural propagation of bass is sufficient in the Great Lakes and other large lakes such as Nipissing and Simcoe that no additional stocking is needed. In the event that it becomes necessary to stock smallmouth bass, a possible source of bass are lakes which are currently closed to bass fishing and therefore have an abundance of fish to spare. Seining was conducted to discover which lakes would be suitable for this practice. Even Fox Lake, in Kenora District, a stocked lake itself (as of 1913) has the potential to act as a supplier for other lakes.

Breeding ponds are also commonly used as a source for bass. Currently, fish introduced in earlier years to Lake on the Mountain are providing fry to smallmouth bass lakes in the vicinity of Prince Edward County. The ponds at the Mount Pleasant Hatchery are presently stocked with bass and golden shiners (as feed) and as the bass reach an agreeable size they will in turn be stocked elsewhere.

ANONYMOUS. 1931$_b$. Planting fingerling bass in Florida. California Fish and Game 17(1) : 91.

Arrangements have been made with the United States Bureau of Fisheries to secure 400 fingerling smallmouth bass from the Federal hatchery to Louisville, Kentucky. These will be sent to Tallahassee shortly after the first of November. Included in the shipment will be 500 fingerling rock bass.

These fish will be placed in the Wakulla River, Suwannee River, Chipola River and the Wacissa River in Jefferson County. These streams were chosen on account of the temperature of the water in the streams, and other characteristics, will be more suitable for these species of fish than the water in the southern part of the state.

ANONYMOUS. 1932. Annual Report of the Ontario Department of Games and Fisheries, 1931. Toronto, Ontario. p. 63.

For the first time pond culture was used to raise 35,000 fry and 18,310 largemouth bass fingerlings in a single experimental pond, in Brantford, Ontario. These fish were then distributed to inland waterbodies.

ANONYMOUS. 1933. Annual Report of the Ontario Department of Games and Fisheries, 1932. No. 9 : 16-17. Toronto, Ontario.

The total output of pond-cultured black bass, both the large-mouthed and small-mouthed species, continues to show a credible increase.

In addition to pond culture a number of lakes and one stream have been used as sources of supply for the purpose of restocking depleted bass waters of the particular region where these lakes and streams are located.

The distribution of black bass in 1932 was as follows:

- Mount Pleasant received 112,000 fry and 3,600 fingerling large-mouths, and 393,000 fry, 19,500 fingerling and 187 adult small-mouths which were pond cultured.
- Wiltse Creek received 1,188 fingerling and 24 yearling largemouths which had been harvested.
- Ingersol Pond received 9,900 fingerling, 2,350 yearling and 161 adult smallmouth bass which were pond cultured.
- Fox Lake received 750 adult smallmouth bass which had been harvested.
- Green Lake received 1,800 yearling smallmouth bass which had been harvested.
- Lake on the Mountain received 195,000 smallmouth fry which had been harvested.
- Little Gull Lake received 2,700 yearlings which had been harvested.

ANONYMOUS. 1934. The Ontario Department of Game and Fisheries Annual Report, 1933. Toronto, Ontario. p. 21-22.

The transference of small-mouthed black bass from one water body to another has remained popular as a stocking technique. Pigeon Lake, Haliburton County supplied 2,600 five to eight inch bass to neighbouring lakes. Bass Lake, in Thunder Bay District donated 688 yearling and adult bass which were then distributed to lakes on St. Ignace Island. There is an increasing demand for small-mouthed black bass in inland waters and impositions of limits and closed seasons are being considered to protect the bass in large lakes where stocking may not be as effective.

ANONYMOUS. 1944. Largemouth bass. Report 1. Union of South Africa, Inland Fisheries Department. 47 p.

ANONYMOUS. 1953. Plantings of game fish in 1953. Ontario Department of Lands and Forests. Whitney, Ontario. 3 p.

The planting of lake trout, speckled trout and smallmouth bass into various lakes in Algonquin Park is reviewed. Cache Lake received 1,000 smallmouth bass fingerlings while Whitefish and Rock lakes received 250 and 295 adult fin-clipped bass, respectively. The fish transferred into the former two lakes originated from Moore Lake, near Madawaska. Moore Lake was considered to be over-crowded with stunted smallmouth bass and the transfer was seen as being beneficial to both the donor and recipient lakes. The majority of the fish planted into Whitefish and Rock lakes died shortly following the transfer.

ANONYMOUS. 1959. Bass planting and transfer of slow-growing fish. p. 9 *In* A Guide to Angling in Algonquin Provincial Park. Ontario Department of Lands and Forests. Whitney, Ontario.

Bass in Algonquin Provincial Park have been planted in numerous lakes from two sources: hatcheries and as transfers from other lakes. The transfer of small adult bass occurs when unfavourable conditions cause bass in a lake to grow slowly so that there is a shortage of large fish. It is standard fisheries procedure to then transfer fish from these overcrowded lakes to another lake to improve the fishery. This results in the thinning of the dense, small-sized population and in turn encourages growth while replenishing a deficient lake. When this procedure was performed between Provoking Lake and Cache Lake, the trout entering Cache Lake (the receiving body) were tagged. Unfortunately survival did not appear to be very high as there was only a 17% return to the creel.

Polly Lake was stocked in the fall with hatchery largemouth bass following a winterkill (caused by a severe oxygen deficiency) in 1952. Regrettably, there is little one can do to avoid these anoxic conditions.

ANONYMOUS. 1961. Mississippi Lake fisheries study 1960-1961. Ontario Department of Lands and Forests. Toronto, Ontario. 49 p.

Smallmouth bass are native to Mississippi Lake, while largemouth bass have made an appearance only recently. Largemouth bass were stocked into the Mississippi River in large numbers between 1951 and 1956 and it is thought that this facilitated their arrival in the lake. From 1946 to 1961, 10,000 fry, 22,150 fingerlings and 232 adult smallmouth bass were released into Mississippi Lake. Although smallmouth bass are available in large numbers they are not preferred game fish since the majority of those angled are infested with yellow grub (*Clinostomum marginatum*). The largemouth bass is not captured very often but the species should do well since there are large areas of suitable habitat in the lake.

ANONYMOUS. 1963. Annual Report of the Minister of Lands and Forests of the Province of Ontario for fiscal year ending March 31, 1963. Toronto, Ontario. p. 107.

Due to the decrease in demand for smallmouth bass fry and fingerlings the rearing ponds at the Mount Pleasant hatchery and Ingersoll ponds were closed.

ANONYMOUS. 1964$_a$. A history of Parry Sound forest district. District History Series No. 12. Ontario Department of Lands and Forests. Toronto, Ontario.

Prior to World War II the Ontario Game and Fisheries branch instituted a fish hatchery at Skelton Lake which specialized in speckled trout, pickerel and bass. For fifteen years annual production consisted of (approximately) 300,000 speckled trout, fingerlings, 35,000,000 pickerel fry and 100,000 smallmouth bass fry.

The enhancement and creation of black bass populations was also carried out through the establishment of sanctuaries in Georgian Bay around 1950 and the transfer of adult bass. Unfortunately these methods had little effect on the bass fishery in Georgian Bay.

ANONYMOUS. 1964$_b$. A history of Kemptville forest district. District History Series No. 17. Ontario Department of Lands and Forests. Toronto, Ontario.

The Westport rearing ponds were built between 1949 and 1951. In the summer largemouth and smallmouth bass were reared and planted as fingerlings, while during the winter the ponds were used to house lake trout, Kamloops and speckled trout. In 1962 72,300 fingerling largemouth bass and 37,600 smallmouth bass fingerlings were distributed. The fish are used for stocking the Kemptville District and neighboring areas.

ANONYMOUS. 1965$_a$. A history of Lindsay forest district. District History Series No. 18. Ontario Department of Lands and Forests. Toronto, Ontario.

As a branch off from his own private hatchery, Samuel Wilmot established the Newcastle Hatchery near Baldwin's Creek in 1867-1868. Following many earlier failures, bass were successfully reared at the hatchery in 1880 and one million fry were distributed to various waterbodies.

The Province of Ontario did not begin distributing bass until 1901. In 1908, bass rearing was finally underway at a provincial hatchery and the fish were even being reared to the fingerling stage. The following fifty years were spent planting bass in many open niches. Between 1910 and 1912 the number of bass plantings in Victoria County increased to such an extent that by 1914 all major waterbodies were being stocked. The planting of bass is now greatly de-emphasized.

ANONYMOUS. 1965$_b$. A history of Sault Ste. Marie forest district. District History Series No. 20. Ontario Department of Lands and Forests. Toronto, Ontario.

Prior to the amalgamation of the Department of Game and Fisheries and Department of Lands and Forests it was common for the District to plant tens of thousands of fish, including black bass, on the request of the public. In 1947, 40,700 smallmouth bass fingerlings were planted in inland waters. In many instances bass and walleye destroyed previously healthy trout populations. Now caution is exerted before proceeding with fish introductions. To ensure that undertaken stocking projects are successful, aircrafts are being used to transport the fish, as opposed to pack cans and horse-drawn vehicles in an attempt at increasing post-stocking survival.

ANONYMOUS. 1967. A history of Sudbury forest district. District History Series No. 21. Ontario Department of Lands and Forests. Toronto, Ontario.

Between the years 1901 to 1905, 35,522 fish, mostly black bass, were distributed into district provincial waters.

ANONYMOUS. 1968. Stream and lake surveys and investigations: Species combinations in small impoundments. Dingell-Johnson Project W. VA F-10-R-10, Job No. III-2, Final Report. West Virginia Department of Natural Resources, Division of Game and Fish. Charleston, West Virginia.

Species combinations and associations were investigated in 12 public fishing impoundments that ranged in size from 5 to 205 surface acres. They were: Castlemans Run Lake, Sleepy Creek Lake, Conaway Run Lake, Bear Lake, Burches Run Lake, Plum Orchard Lake, Turkey Run Lake, Bonds Creek Lake, Sherwood Lake, Moncove Lake, Cornstalk Lake and Warden Lake.

A species combination history of all lakes was compiled and contained in addition to a stocking history, information on whether or not the lake was reclaimed, age of impoundment, and if bait minnows are permitted.

A rating chart utilizing available population, creel census and age and growth data was prepared. Arbitrarily selected categorical values from 0 to 4, lowest to highest, respectively, were used to give numerical value to each parameter. These values were then averaged to arrive at a final value. Final values ranged from zero in Warden Lake to 3.2 in Bonds Creek Lake.

Stocking largemouth bass alone in new or reclaimed lakes appears to be a sound management practice to achieve optimum growth and harvest for the first two years; however, to maintain good fishing, additional game and/or forage species should be stocked in the second or third year.

ANONYMOUS. 1973. Bass plantings. p. 18 *In* Fishing in Algonquin Provincial park. Ontario Department of Lands and Forests. Whitney, Ontario.

Two sources have been used for plantings of bass in Algonquin Park: (1) young hatchery fish and (2) adult fish transferred from another lake. The stunted, crowded population of smallmouth bass at Provoking Lake was thinned by transferring bass to Lake Of Two Rivers. Other transfers have been made to Cache, Whitefish and Rock lakes.

Plantings of hatchery bass began in 1962 in the Park. It is hoped that these will supplement already established populations by contributing to the angler's creel and reinforcing poor year classes.

ANONYMOUS. 1979. Summer angling census, 1979. Ontario Ministry of Natural Resources. Kemptville, Ontario.

In the summer of 1979 angling quality censuses were conducted on Black, Little Silver, Long, Pike, Bower/Park/Wood, Kerr, Patterson and Silver lakes. Morphometric data on each lake as well as the results of the census in terms of angling pressure, catch and harvest rates are discussed. The schedule for this census accompanied by the stocking histories of the lakes and a cost analysis of fish planting is presented in the appendices. The total numbers of bass stocked were found to be:

- Black Lake: 3,000 largemouth bass fingerlings between 1951 and 1959 and 79,400 smallmouth bass between 1921 and 1979.
- Little Silver Lake: An unknown number of largemouth bass was introduced in 1951.
- Pike Lake: 100 adult largemouth bass were introduced in 1932 and 43,150 smallmouth bass fingerlings and adults were stocked between 1930 and 1963.
- Kerr Lake: 19,250 smallmouth bass fingerlings were planted between 1939 and 1961.
- Patterson Lake: 21,969 smallmouth bass fry, fingerlings and adults stocked between 1930 and 1967.

ANONYMOUS. 1986. C. F. I. P. project report: Largemouth bass transfer from Devine Lake, (Lake of Bays Township) to Roys and Mudswamp lakes, (Sabine Township). Ontario Ministry of Natural Resources. Bracebridge, Ontario. 1 p.

In 1986, a C. F. I. P. grant was given which allowed the transfer of largemouth bass from Devine Lake to Roys and Mudswamp lakes. Devine Lake was chosen as a donor lake because of its largely stunted population. Ministry of Natural Resources employees and volunteers from Hay Lake Lodge angled and trap-netted seventy bass from Devine Lake and transported them using a 0.67 m^3 insulated fish holding tank (initial temperature 25°C) which received continuous oxygenation. No ice was used and the total transportation time was two hours.

Fifty-one of the bass were placed into Roys Lake and 19 into Mudswamp Lake. No mortalities occurred during the transfer.

ANONYMOUS. 1997. Smallmouth bass take hold at Lake Eufaula. The Shawnee-News Star. http://www.news-star.com/stories/111697/spo_wbass.html.

The initial introduction of smallmouth bass at Lake Eufala took place in 1992 when fry were stocked. In each subsequent year pond-raised fingerlings were stocked. The first evidence of natural reproduction by the smallmouth bass has recently been uncovered at two separate locations on Lake Eufaula. These sites were the original planting sites for the fry, and there is evidence that the bass are spreading out into previously uncharted territory.

ANONYMOUS. 1998. Santee Cooper working with South Carolina Department of Natural Resources bass stocking project. http://www.santeecooper.com/whoweare/98release/bass.html.

Largemouth bass stocking experiments are planned by the South Carolina Department of Natural Resources and state-owned utility Santee Cooper in Marion and Moultrie lakes. This decision comes following a major reduction in the amount of hydrilla in the two lakes. The stocking is set for late May and will result in approximately 450,000 fingerlings being planted. One year from now one-year-old bass will also be planted and since fish tend to remain close to their site of stocking biologists will be able to compare stocked and unstocked populations. Ideally the need to continuously stock bass will be unnecessary and the native population will return to its original numbers on its own.

ANONYMOUS. 1999. Fish stocking begins at Silverwood Lake. California Department of Water Resources NEWS. http://wwwdwr.water.ca.gov/dir-dwr_news_releases-1999R2/Sept.30%2C99-Fish_Stkg_Slvwd.html.

In hopes of revitalizing the bass fishery at Silverwood Lake, in northern San Bernardino County, the California Department of Water Resources began stocking Florida largemouth bass on the week of September 30, 1999. By the end of October, approximately 3,500 largemouth bass will have been planted in the lake. Fifteen hundred of the fish will be of varying sizes and ages and will be shipped in from the Willow Creek Fish Farm, while the remaining 2,000 largemouth bass will range in size from 12 to 20 inches and will be transplanted from various lakes in the San Diego area. It is hoped that this restoration plan will enhance the largemouth bass populations.

APPLEGATE, R. L. and W. L. KRUCKENBERG. 1978. First-year growth and food of largemouth bass in a South Dakota burrow pit stocked with fathead minnows. Progressive Fish Culturist 40 : 7-8.

A South Dakota burrow pit was stocked with largemouth bass (*Micropterus salmoides*) and fathead minnows (*Pimephales promelas*) in 1976, and first-year growth and food of the bass were studied. The mean total length and weight of largemouth bass increased from 57 to 159 mm and from 2.5 to 61 g. Water boatmen (*Corixidae*) made up 44.8% of the food volume, fathead minnows 26.0%, mayfly nymphs (*Ephemeroptera*) 18.9%, back swimmers (*Notonectidae*), midges (*Chironomidae*), and damselfly nymphs (*Odonata*) 10.3%. The largemouth bass never became primarily piscivorous. Boards placed in the ponds for fathead minnow spawning were also used by corixids for ovipositing and may have increased corixid production. Forage fish were apparently not essential as food for young-of-the-year largemouth bass.

ARCHAMBAULT, J., B. BERGERON, P. DUMONT, O. GAUTHIER, M. LAPOINTE and R. PARISSEAU. 1990. Stocking guidelines for fish species other than anadromous Atlantic salmon. Québec Ministère du Loisir, de la Chasse et de la Pêche. Québec City, Québec. 27 p. + appendices.

The stocking of smallmouth bass is carried out according to the size of the water body. Fry can be planted in any water measuring from 0 to 5,000 surface hectares. The maximum number which should be planted is

25,000, at the rate of 100/ha. In lakes with 50-450 surface ha between 100 and 150 adults can be stocked. In waters between 450-5,000 surface ha one adult should be stocked for every 3 ha up to a maximum of 400 fish.

The F_1 strain of fry is preferred for stocking and the donor body for the adults should be similar in chemical, biological and physical characteristics to the recipient lake. Fry should be distributed into areas where the water depth varies from 0 to 6 m. Smallmouth bass should not be stocked into waters which contain salmonids or which contain suitable salmonid habitat. Also it has been found that smallmouth bass are unsuitable for put-grow-and-take fisheries.

ARMSTRONG, K. B. 1985. Investigations on the colonization of smallmouth bass (*Micropterus dolomieui*) in Elliot Lake, 1982-1985. Algoma Fisheries Assessment Unit. Ontario Ministry of Natural Resources. Sault Ste. Marie, Ontario. 12 p.

It is speculated that smallmouth bass were introduced into Elliot Lake sometime during the late 1970s. Their presence was first noted in 1982 and the population has been monitored since that time through annual tagging programs. Apparently the fish have colonized the entire lake and the sampling has demonstrated that the 1977 year-class is likely the oldest. The mean size of the bass appears to be declining, as is natural in an introduced species which is only becoming acclimatized to its niche. It is expected that this species will soon be providing another sport fishery on Elliot Lake.

ARMSTRONG, K. and R. MACKERETH. 2000. Colonization, distribution, and consequences of smallmouth bass invasion throughout northwestern Ontario. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

Smallmouth bass (*Micropterus dolomieu*) are not indigenous to Northwestern Ontario but have been expanding their range since they were first stocked in the early 1900s. In 1987 there were 382 known bass waterbodies but by 1998 that number exceeded 700. Stocking of smallmouth bass has never been promoted by the provincial management agency but the number and location of new populations cannot be explained by natural movement patterns through watersheds. The area is considered to be the northern extent of smallmouth bass range, however, early growth is typically sufficient to attain the minimum size necessary for over-winter survival and within lake populations have been expanding. Creel survey data demonstrate a strong negative correlation between targeted success for walleye, the region's main sport fish, and smallmouth bass in the same waterbody. The mechanism responsible for the negative interaction is not understood. Although smallmouth populations have become established in a wide variety of lake types, multivariate analyses suggest higher bass densities occur in large, deep, irregularly shaped lakes that have low productivity. Rapid range expansion and possible interactions with other species now have managers concerned about the impacts of bass on the quality of the fisheries for other species.

ARVE, J. E. 1961. Maryland statewide inland fisheries investigations: Determine the survival rate of largemouth bass and associated species from stocking and tagging largemouth bass. Dingell-Johnson Project MD F-10-R-4, Job No. 1-A. Maryland Department of Game and Inland Fish. Baltimore, Maryland. 10 p.

AYERS, H. D., H. R. McCRIMMON and A. H. BERST. 1967. Construction and management of farm ponds in Ontario. Ontario Department of Agriculture and Food 515. Guelph, Ontario. 43 p.

Largemouth bass are typically stocked in combination with either bluegills, fathead minnows or golden shiners. There is no proof in Ontario; however, that there are any significant benefits to stocking largemouth bass with forage fish. Smallmouth bass stocked into ponds has also proven to give satisfactory results, although its use is less common than that of the largemouth. The stocking rate most commonly used when planting either bass species (alone) is 100 fingerlings (1-3 inches), 25 yearlings (5-7 inches) or 10 adults per surface acre of water.

AZOUZ, A. 1970. Results and evaluations of recent introductions, in various regions. FAO Aquaculture Bulletin 2(2) : 17-18.

Since the 1800s the black bass has been introduced into a variety of different areas. Since 1934, numerous species have been introduced to Morocco, among them the largemouth bass (*Micropterus salmoides*) originating from France. This introduction has been successful and Morocco has in turn supplied Tunisia with largemouth bass.

BAIN, J. 1993. An introduction of smallmouth bass to the Gaspereau River System, Kings County, Nova Scotia. Report to Nova Scotia Department of Fisheries. Halifax, Nova Scotia.

BALDWIN, N. S. 1947$_a$. Plantings of fish in southern Algonquin Park waters, 1947. Ontario Department of Lands and Forests. Whitney, Ontario. 8 p.

In order to encourage higher fish population numbers in certain Algonquin Park lakes, hatchery game-fish were planted, along with ciscos, for lake trout forage. In 1947, 1,000 hatchery smallmouth black bass fingerlings were planted at Cache Lake and the stocking of cisco, lake trout and speckled trout occurred in other lakes. To evaluate the success of these plantings a creel census was conducted.

The survey discovered that 105 smallmouth bass, averaging 11.5 inches in length, were angled from Cache Lake waters in 1947. The fishery had almost disappeared in 1946 and is thus showing signs of recovery.

BALDWIN, N. S. 1947$_b$. The gill-netting of pike and the planting of smallmouth bass in Lake Mary Louise, Sibley Park, 1947. Ontario Department of Lands and Forests. Thunder Bay, Ontario. 2 p.

Concerns of the detrimental effect that the pike population was having on small-mouth bass led to gill-netting starting in 1946 to reduce the mortality of the planted small-mouth black bass. Following one month of gill-netting, small-mouth bass were planted into the lake. The transfer consisted of 450 bass, 8 to 10 inches in length from Cooke's Lake on August 5, 1947. In addition to the plantings in 1946, 800 smallmouth bass have been added to the lake. Even with the gill-netting, no signs of spawning were observed, yet it is too early to draw any conclusions concerning the success or failure of the bass stockings.

BALDWIN, N. S. 1949$_a$. Progress report on the returns from planting wild smallmouth bass in Cache Lake, Algonquin Park. Unpublished Manuscript. Ontario Fisheries Research Laboratory. Ontario Department of Lands and Forests. Whitney, Ontario. 5 p.

BALDWIN, N. S. 1949$_b$. Progress report on the bass transfer from Provoking Lake to Lake of Two Rivers, Algonquin Park. Unpublished Manuscript. Ontario Fisheries

Research Laboratory. Ontario Department of Lands and Forests. Whitney, Ontario. 3 p.

BALDWIN, N. S. 1950. The Algonquin Park creel census 1950. File Report. Ontario Department of Lands and Forests. Whitney, Ontario. 11 p.

During the last 15 years a creel census conducted in Algonquin Park has been following management trends such as the closure of lakes to fishing, the plantings of lake trout, speckled trout, bass and water control and fertilization as a means to increase population numbers.

Smallmouth bass were transplanted into Cache Lake in hopes of creating a successful fishery. Years later, Lake Opeongo remains the most productive in terms of fish caught. The creel census has demonstrated that in few of the ten water bodies surveyed does the smallmouth bass survive once it enters the fishery. For this reason bass fingerlings are being planted in Cache Lake to strengthen any year classes which may be weak.

BALDWIN, N. S. 1951. Returns from planting wild smallmouth bass in Cache Lake, Algonquin Park, in 1948. File Report. Ontario Department of Lands and Forests. Whitney, Ontario. 5 p.

In late June 1948 approximately 750 smallmouth bass from 6 to 14 inches in length were transferred from various crowded lakes in Algonquin Park to Cache Lake where the smallmouth bass population appeared to have crashed temporarily.

Transferred fish had a celluloid tag attached behind their dorsal fin and a portion of the fish were marked by the removal of one of the paired fins.

The majority of the recaptures had lost their tags. It is estimated that a total of 121 planted bass were caught in Cache Lake from 1948-1950, with an additional six being caught in adjoining Tanamakoon Lake. No marked bass were reported caught in 1951. The fish comprised 18% of the total catch in Cache Lake in the two years following planting.

BALDWIN, O. N. 1926. Some observations on the production of large-mouthed black bass at San Marcos, Texas, Fisheries Station. Transactions of the American Fisheries Society 56 : 50-52.

The large-mouthed black bass is considered the most important freshwater fish in Texas. At the San Marcos Fisheries Station, adult bass (the brood stock) were planted in eight separate ponds for the purpose of fish production. The densities of bass planted varied only slightly. In Ponds 1 through 4, each measuring 0.67 acre, 30 adults were planted; Pond No. 5 measured 0.58 acre and also received 30 adults; Pond No. 6, 0.79 acre received 40 adults; and Pond No. 7, 0.21 of an acre received 20 adults. Pond A was larger than the others, being 1.10 acres and was stocked with 100 small adults. All fish were fed live minnows.

The number of fingerlings produced per pond varied greatly between ponds. Ponds Nos. 1 through 4 produced between 4,150 and 38,250 fingerlings. Pond A and No. 5 produced the highest numbers of fingerlings, 79,230 and 59,940, respectively. Ponds Nos. 6 and 7 produced nearly identical numbers of fingerlings, 23,029 and 23,625, respectively. It was suspected that flooding drastically diminished the fingerling population in Pond No. 6. Because the fish were stocked prior to the ripening of the females it is hypothesized that the number of males stocked was much higher than females in some ponds, accounting for the discrepancy in fingerling production.

BALDWIN, R. W. 1980$_a$. Largemouth bass transfers and introductions, Parry Sound District, 1979. File Report. Ontario Ministry of Natural Resources. Parry Sound, Ontario. 6 p.

An ongoing programme to establish sport fisheries in small shallow-water lakes within the Parry Sound District was continued in 1979 under the Experience 1979 Programme.

Largemouth bass were introduced to four lakes, namely Cranberry Lake, Harrison Twp.; and Whalley Lake, Chapman Twp. In conjunction with the bass introduction in Cranberry Lake, a total of 3197 brown bullheads and 45 bowfin were removed to reduce possible predation on any future spawning success by largemouth.

BALDWIN, R. W. 1980$_b$. An evaluation of the success of largemouth bass introductions into Dinner Lake, Carling Township, and Mead Lake, Monteith Township, Parry Sound District. File Report. Ontario Ministry of Natural Resources. Parry Sound, Ontario. 11 p.

During the summers of 1979 and 1980, test netting of two of twelve District lakes which have received introductions of largemouth bass in recent years was conducted. Evaluation of the success of these introductions, based on the test netting results, has now been completed for Dinner Lake, Carling Township, and Mead Lake, Monteith Township. The presence of large numbers of two year old largemouth bass found in Mead Lake during the summer of 1979 is indicative of the successful spawning which occurred during the first spring following the 1976 introduction. Extensive netting in Dinner Lake did not catch a single largemouth bass. Not only did the negative results indicate a lack of reproduction but it also indicated that there were no survivors of adult bass from the 1978 planting.

BALL, R. C. 1952. Farm pond management in Michigan. Journal of Wildlife Management 16(3) : 266-269.

Cooperation between the Michigan Institute for Fisheries Research and Michigan State College have resulted in experimental pond population combinations involving many species of fish including: the largemouth bass, the smallmouth bass, bluegills, bullheads, redear sunfish, hybrid sunfish (redear sunfish x pumpkinseed sunfish), and many species of minnows.

Results demonstrated that combinations of largemouth bass and golden shiners were satisfactory in weedy ponds, because enough shiners escape predation to continuously provide food for the bass. The redear sunfish provides adequate forage for the bass, yet is not as desirable a sportfish as the bluegill. Bass and bluegills provided the best results. Because of the short growth season for bass and bluegills (6 months), maturity is delayed until the third summer for bass and the second summer for bluegills. We believe that in Michigan hardwater ponds dense vegetation provides shelter for the bluegills to such an extent that the bass are unable to adequately control their numbers. Therefore, it is recommended that new ponds be stocked with 100 bass fingerlings and 100 adult bluegills per acre.

BALL, R. C. and H. D. TAIT. 1952. Production of bass and bluegills in Michigan ponds. Michigan State College Agricultural Experiment Station Technical Bulletin 231. East Lansing, Michigan. 24 p.

In 1947, six experimental ponds were stocked with combinations of largemouth bass and bluegills. The bass were stocked first, on April 15 and the bluegills approximately a month later on May 20. The ponds were paired, with one-half of the pair receiving inorganic fertilizer treatment.

Yearling bass stocked in 1947, weighed around one pound each when removed from the pond in September, 1949. In ponds stocked with yearling bluegills and yearling bass, the bass grew very slowly in contrast to those planted with adult bluegills. The ponds stocked with fingerling bass and adult bluegills produced bass which reached up to 10.6 to 11.9 inches at the end of their second year in the pond. However, the number of bass in the ponds stocked alongside yearling bluegills was twice as much as that in the ponds with the adult bluegills. From these experiments, in which ratios of 150 bass to 18 bluegills, 150:50, 390:2,540 and 500:3,000 were used, conclusions have been drawn as to which ratios will yield the greatest number of largemouth bass of the highest quality. It is recommended that 150 fingerling largemouth bass and 10 adult bluegills be planted per acre. This ratio should yield catchable-sized bluegills and give the bass a quality initial growth.

BARRON, J. C. 1966. Stocking recommendations. Dingell-Johnson Federal Aid Project TX F-6-R-14, Job B-25. Texas Parks and Wildlife Department. Austin, Texas.

BASTEDI, S. T. 1903. The stocking of inland waters with black bass. Rod and Gun in Canada 5(1) : 25-26.

BEACH, D. R. 1974. Experimental introduction of smallmouth bass into Anderson Ranch Reservoir. Dingell-Johnson Federal Aid Project ID F-53-R-9. Idaho Department of Fish and Game. Boise, Idaho.

BEATY, P. R. and W. F. CHILDERS. 1980. Hybridization of northern largemouth bass (*Micropterus salmoides salmoides*) and northern smallmouth bass (*Micropterus dolomieui dolomieui*). Natural History Survey, Report to the Bass Research Foundation. Starkville, Mississippi.

BECK, R. D. 1986. Growth, survival and reproductive success of largemouth bass stocked with selected forage fishes in South Dakota ponds. Fish and Wildlife Reference Service. Rockville, Maryland. 54 p.

BENNETT, D. H., J. A. CHANDLER and L. K. DUNSMOOR. 1989. Smallmouth bass in the Pacific Northwest: Benefit or liability? p. 126-135 *In* D. C. Jackson [ed.]. The First International Smallmouth Bass Symposium, August 24-26, 1989, Nashville, Tennessee.

Smallmouth bass (*Micropterus dolomieui*) were introduced into Oregon, Idaho and Washington in the early 1900s. Since then, some populations have flourished and provide important recreational angling opportunities, especially in coolwater reservoirs constructed on large river systems. Smallmouth bass in these systems forage primarily on fish and crayfish; however, insects and zooplankton also provide important forage. Smallmouth bass are beneficial to the region because they provide sport fisheries in systems too warm for salmonids. However, marginal water temperatures result in high overwinter mortality, shorter growing seasons and subsequently it takes 3 to 5 years for smallmouth bass to attain catchable size (300 mm) and sexual maturity. Populations are characterized by low standing crops and low proportional stock densities.

The negative side of smallmouth bass is their role as a predator on migratory salmon smolts. Although water temperatures during the smolt outmigration in the Snake and Columbia River systems range from 8 to 14°C, smallmouth bass prey on Pacific salmon (*Oncorhynchus* spp.) and steelhead (*O. mykiss*) smolts immediately downstream of dams and throughout the reservoirs. This predatory role makes smallmouth bass a less desirable sportfish with management agencies responsible for the restoration of the anadromous salmon fishes. Regardless, habitat conditions are favorably suited for smallmouth bass and interest will only increase in the Pacific Northwest.

BENNETT, G. W. 1948. The bass-bluegill combination in a small artificial lake. Bulletin of the Illinois Natural History Survey 24 : 377-412.

BENNETT, G. W. 1951. Experimental largemouth bass management in Illinois. Transactions of the American Fisheries Society 80(1950) : 231-239.

A fishing cycle characteristic of new water-supply reservoirs in Illinois can be predicted with a high degree of accuracy. This sequence of events poses several questions which have been answered at Ridge Lake (18 acres) during the past 9 years, largely through population manipulation during biennial draining for enumeration of fish. A complete creel census tests the value of population adjustments. In this period of study, fishermen have taken 3,228 largemouth bass weighing 2,385 pounds and 8,169 bluegills weighing 1,168 pounds. Biologists have removed on draining censuses 6,406 small bass weighing 862 pounds and 94,582 small bluegills weighing 4,859 pounds. These fish all originated from 435 bass stocked in 1941 and 129 bluegills stocked in 1944. The hook-and-line yield of bass has varied between 10.9 and 30 pounds per acre per year.

Four censuses have indicated that the maximum carrying capacity of the lake for bass was about 50 pounds per acre. When the bluegill population was allowed to expand to 193 pounds per acre, the bass population was depressed to 31.5 pounds per acre. During years when the population of small bass and bluegills was thinned in March, the June reproduction of bass averaged 54,200 schooling fry. In alternate years, when the lake was not drained and contained many small fish of the preceding year, the average bass reproduction was only 5,900 schooling fry. In the alternate years of 1948 and 1950, no schools of young bass were found, no young bass were taken in seining with a 1/8-inch mesh minnow seine in 1948, and only one was taken in 1950. The bass population of Ridge Lake has been maintained at a high level, in spite of the fact that small bass were removed on draining censuses and that since 1945, fishermen have been asked to remove them from the lake when caught. This suggests that legal length limits have no value in bass conservation. The differential in spawning and years when they were not, casts doubt on the utility of closed seasons and bag limits. Bass have always been protected at Ridge Lake during the spawning season, yet there has been no correlation between the number of bass of spawning size in the lake and the number of young bass produced. In the author's opinion, bass populations in Illinois bear no direct relationship to populations of other fishes, except that they may be depressed by them.

BENNETT, G. W. 1952. Pond management in Illinois. Journal of Wildlife Management 16(3) : 249-253.

Adequate rainfall and tight subsoils over much of Illinois ensure that artificial ponds are simple to maintain. New ponds are stocked by the Department of Conservation following inspection by State biologists and old ponds may have to be cleared prior to the introduction of any fish.

The largemouth bass and bluegill combination is most frequently used when stocking new or newly cleared ponds. Stocking must be executed in a manner which allows the bass to immediately become abundant. Unfortunately, the bass population can easily lose control over that of the bluegills, causing the population of the former to become stunted. This inability to control is thought to be caused by two factors: (1) bluegills spawn after only one year of life, whereas it takes bass in Illinois until age-2 to mature; (2) impoundments have a tendency to quickly develop large populations of crayfish which are then chosen by the bass as food instead of the bluegills.

The planting rate of 50 to 100 bass per acre has demonstrated a certain level of success in ponds one to twenty-five acres in size. Fingerling bluegills may be stocked in equal numbers at the same time as the bass or shortly after. If other species are stocked alongside, or instead of, bluegills the total number of these companion fishes is *not* to exceed 100 per acre. In ponds between 5 and 25 acres it can be beneficial to stock 1 to 3 sexually mature bass to allow rapid population of the pond.

There are alternatives to the bluegills if forage fish overpopulation becomes a problem. Populations of warmouth and redear sunfish do not tend to explode like those of bluegills, yet on the downside neither are as desirable a sportfish as the bluegill.

For those pond owners whose primary interest is fishing for bass, then largemouth, smallmouth and spotted bass all do well when stocked on their own.

BENNETT, G. W. 1954. Largemouth bass in Ridge Lake, Coles County, Illinois. Illinois Natural History Survey Bulletin 26(2) : 217-276.

Ridge Lake, the dam for which was completed in April, 1941, is an artificial impoundment that at overflow level in 1941 had an area of 18.1 acres and a maximum depth of 25 feet. It was made by damming Dry Run Creek, a tributary of the Embarrass River, in Coles County, Illinois. Silting of the lake basin was and is a serious problem. The lake is eutrophic-like in character in that it has no dissolved oxygen in the deep water in summer.

The lake was stocked in 1941 with 435 bass, in 1944 with 129 bluegills, and in 1949 with 138 warmouths. In 1942 and most subsequent years, the public was allowed to fish from boats belonging to the Natural History Survey, and a record was made of kinds, numbers, and weights of all fish caught, time spent fishing, types of bait used and the tackle used. The lake was closed to public fishing in 1943 and until August 1944.

At intervals of 2 years, beginning in 1943, the lake was drained in early spring and a census made of the fish. After each census the large bass (minimum length 10 inches in most years, 8 or 9 in others) were marked by fin-clipping and returned to the partially refilled lake basin.

No stocks of fish, other than those released in 1941, 1944 and 1949, were introduced into Ridge Lake from other bodies of water. Between 1941 and 1951 more than 11,000 bass and 154,000 bluegills were permanently removed from the lake by angling and draining censuses. Of these, 3,743 bass and 9,000 bluegills were taken by anglers.

The weight of bass taken in the five draining censuses ranged from 31.5 pounds per acre in the 1947 census to 50.4 pounds per acre in the 1949 census. These poundage calculations suggest that the carrying capacity of Ridge Lake for bass may be about 50 pounds per acre.

Yields of bass taken by angling during years in which the lake was open to public fishing varied between 10.9 and 30.0 pounds per acre.

Estimates of numbers of bass fry were made during the spawning season of each year, 1941 to 1951, inclusive. In years in which the lake was drained estimates ranged from 18,000 to 116,000 and averaged 50,500. The estimates were much lower in years that the lake was not drained, ranging from 0 to 26,000 and averaging 5,900.

There was no apparent relationship between the number of bass of spawning age in the lake in any given season and the number of bass fry produced in that season.

The ratios of numbers of bass fry of a brood to individuals of the same brood taken as larger fish in the 21 months after spawning varied between 29 to 1 and 40 to 1, in 1941, 1943, 1947, and 1949. In 1945, when the number of bass fry was unusually high, the survival ratio was 195 to 1.

BENNETT, G. W. 1972. Ecology and management of largemouth bass. p. 10-17 *In* J. L. Funk [ed.]. Symposium on Overharvest and Management of Largemouth Bass in Small Impoundments. American Fisheries Society Special Publication No. 3. Bethesda, Maryland.

Total numbers of largemouth bass removed from Ridge Lake over the past 30 years were 35,400 weighing 10,200 lb. These fish were taken by fishermen and in drainage censuses after which only the larger fish were restocked. No additional bass have been stocked since the original release of 100 adults and 335 yearlings in 1941. In 10 draining censuses during the 30-year period the bass population has ranged in numbers between 1,500 and 6,000. In spite of annual exploitation rates as high as 60%, bass were capable of replacing their numbers and weights during a single season. Small numbers of large fish were always present in spite of no restrictions on lengths or numbers of bass that may be taken by fishermen.

BENNETT, G. W., H. W. ADKINS and W. F. CHILDERS. 1969. Largemouth bass and other fishes in Ridge Lake, Illinois, 1941-1963. Illinois Natural History Survey Bulletin 30(1) : 1-67.

Ridge Lake was stocked with 335 yearling largemouth bass and 100 adults in 1941, 129 bluegills in 1944, 138 warmouths in 1949, and varying numbers of channel catfish in 1951, 1952, and 1957. After an attempt to remove all bluegills by draining the lake and leaving the lake basin empty over the winter of 1959-1960, 585 lake chubsuckers and 4,500 hybrid sunfishes were stocked in the spring of 1960.

Since the beginning of this study in 1941, 29,700 largemouth bass, 390,000 bluegills, and about 10,000 warmouths have been permanently removed from the lake. The lake now (1969) contains adequate numbers of all species stocked except channel catfish, which did not reproduce successfully in standing water.

A complete creel census has been conducted at Ridge Lake each summer except in 1941 and 1943, when the lake was closed to public fishing. In addition, the lake was drained and the fishes were censused in the springs of 1943, 1945, 1947, 1949, 1951, 1953, 1956, 1959 (fall), and 1963, and selected kinds, sizes, and numbers of fish were held alive and restocked.

In the nine draining censuses at Ridge Lake bass total numbers varied between 1,500 and 6,000 and their total weights between 205 and 412 kg. Standing crops of largemouth bass varied between 35 and 56.6 kg per hectare. In four censuses the standing crops of bass approached or slightly exceeded 56 kg per hectare, suggesting that this weight may represent the maximum this lake will support.

There was a close relationship between bass and bluegills. Usually when bass weight increased, bluegill weight decreased, and vice versa. It was found that biennial lake draining with the culling of small bass and bluegills increased the numbers of large bass and was selective for fast growing ones.

Bass fry production after draining and culling of small fishes of all kinds averaged 7,917 per hectare; after drawdowns, 3,243 per hectare; and after 1 or more years of stable water levels, 1,023 per hectare. Most bass disappeared from the lake at ages 7-10 years, although a few lived for 10, 11, and 13 years.

Seasonal exploitation rates from catches of marked largemouth bass ranged from 1.5 to 63%. Natural, nonfishing mortality for largemouth bass at Ridge Lake (figured for 2-year-olds) was 33% for bass weighing 0.07-0.34 kg, about 14% for sizes between 0.35 and 1.81 kg, 39% for sizes between 1.82 and 2.27 kg, and 73% for sizes over 2.27 kg.

In 3 poor fishing years the average number of large bass present per hectare was 59, and small ones averages 123, a total of 182 per hectare. The average annual catch of desirable-sized largemouth bass (25 cm or longer) per hectare was 47, weighing 19.2 kg, under biennial draining and culling.

BENNETT, G. W., H. W. ADKINS and W. F. CHILDERS. 1973. The effects of supplemental feeding and fall drawdowns on the largemouth bass and bluegills at Ridge Lake, Illinois. Illinois Natural History Survey Bulletin 31(1) : 1-28.

After a draining census in 1963, Ridge Lake was restocked with 2,386 largemouth bass, 4,492 bluegills, 1,335 warmouths, 11 channel catfish, and 1,020 lake chubsuckers, making a total of 9,244 fishes weighing 510.6 kg (1,125.5 pounds). This was 78.8 kg per hectare, or 70.3 pounds per acre. In the census preceding this restocking this lake was found to contain 287 kg per hectare or 256 pounds per acre, almost four times the weight of fish returned to the lake. In 1969, 2,000 additional channel catfish were stocked.

The population of fishes was allowed to expand for two growing seasons (1963 and 1964) without drawdowns or supplemental feeding but with the usual controlled public fishing during the summer months. The hook-and-line catch in 1963 and 1964 was below the average for the preceding 20 years.

Beginning in late May 1965, and continuing each year during the 3 summer months, 1965 through 1969, the fish were fed daily on a commercial pelleted fish food (32% protein) at the rate of 2 pounds per acre per day. Food was spread in the shallow in all parts of the lake. The food cost was within $27.80-$30.12 per hectare per season ($11.25-$12.19 per acre per season).

Each year, beginning in September 1965, the lake level was lowered:

- 4.6 m (15 ft) in 1965, leaving a surface area of 2.12 ha.
- 3.0 m (10 ft) in 1966, leaving a surface area of 4.5 ha
- 3.0 m (10 ft) in 1967, leaving a surface area of 4.5 ha
- 4.6 m (15 ft) in 1968, leaving a surface area of 2.12 ha
- 4.3 m (14 ft) in 1969, leaving a surface area of 2.76 ha

This level was maintained until the water temperature in the lake was about 13°C (57°F) in October, when the lake was allowed to refill.

In March 1970, the lake was drained to make a census of the fishes. The lake contained 2,420 bass, 9,546 bluegills, 1,477 channel catfish, 232 lake chubsuckers, and 3 fishes of other species, a total of 14,234 fishes weighing 1,440.0 kg (3,175.3 pounds).

The catch of largemouth bass during the seasons 1965-1969, inclusive, was composed mostly of small fish. The f-d program resulted in the production of excessive numbers of small bass but generally did nothing to improve bass fishing. The average hook-and-line yield of bass in the 5 f-d years was only 18.0 kg per ha. This yield was below the average for the drawdown years (1952, 1954, and 1955) and 3 stable water level years (1957, 1958, 1959).

The average index of condition of largemouth bass in the f-d period was slightly below normal, whereas average bluegill condition was considered "fat." Largemouth bass growth was slower during the f-d period than during the period of biennial lake draining and culling of the fish population.

BENNETT, G. W. and W. F. CHILDERS. 1957. The smallmouth bass (*Micropterus dolomieu*) in warm-water ponds. Journal of Wildlife Management 21(4) : 414-424.

Smallmouth bass were able to live in 12 ponds representing most types of warm-water pond habitats located at or north of the latitude of central Illinois. They were observed to reproduce successfully in one-half (6) of these ponds during and prior to the summer of 1956. Failure of smallmouths to reproduce in the other 6 ponds was believed to be related to (1) an absence of sexually mature fish or (2) their inability to compete successfully with largemouth bass and green sunfish.

Most successful smallmouth bass ponds were those in which smallmouths were by themselves or with some other fish less prolific than bluegills, green sunfish or black bullheads.

A population of smallmouths in one lake (14.6 acres) expanded from 32 fish to 2,969 in two growing seasons. In the next four growing seasons this population dropped from 697 bass returned following the 1952 census to 148 fish; the reduction was due to angling and failure of reproduction due to excessive competition with sunfish.

A 1.4-acre gravel-pit pond produced hook-and-line yields of smallmouth bass ranging from 78 to 123 pounds per acre during the fishing seasons of 1951-54, inclusive. These fish were caught at an average rate of about two fish or one pound per hour. When the pond was censused, it contained 52.3 pounds of bass per acre. This suggested the possibility of an annual turnover of more than 100% of the standing crop.

Smallmouths living alone in ponds became habitual surface feeders and for this reason were more easily taken on artificial flies and other surface lures than were smallmouths living in ponds with other kinds of fishes.

BENNETT, G. W. and W. F. CHILDERS. 1966. The lake chubsucker as a forage species. Progressive Fish Culturist 28(2) : 89-92.

The lake chubsucker was planted into various waterbodies to determine its use as a forage fish. Giffin's Pond (8 surface acres) was stocked with 100 lake chubsucker and 1,118 largemouth bass fry in 1960 and since 1961 fishing has been good. We believe that the lake chubsucker makes for a very satisfactory forage species, especially in ponds and small lakes where the owners are interested in bass fishing and not in controlling excessive numbers of bluegills and other sunfish.

BISHOP, H. 1971. Largemouth bass culture in the southwest. p. 24-27 *In* R. J. Muncy and R. V. Bulkley [eds.]. Proceedings of the North Central Warmwater Fish Culture and Management Workshop. Iowa Cooperative Fisheries Unit, January 21-22, 1971, Ames, Iowa.

BIVINGS, A. E. IV and R. L. NOBLE. 1981. Variation in first year growth of largemouth bass in a north Texas farm pond. Annual Proceedings of the Texas Chapter of the American Fisheries Society 3 : 83-91.

BLISS, Q. P. 1971. Survival of stocked largemouth bass in southeastern Nebraska. p. 201-294 *In* R. J. Muncy and R. V. Bulkley [eds.]. Proceedings of the North Central Warmwater Fish Culture Management Workshop, Iowa Cooperative Fisheries Unit, January 21-22, 1971, Ames, Iowa.

BOND, C. E. 1958. Determination of fish species and management practices best suited to farm ponds in Oregon. Progress Report, Oregon Agricultural Experiment Station Project 294. Salem, Oregon. 27 p.

BONHAM, K. 1946. Management of a small fish pond in Texas. Journal of Wildlife Management 10(1) : 1-4.

Management of a half-acre pond in Brazos County, Texas, was conducted by the help of students at Texas A and M College. The original fish population was virtually eliminated through rotenone poisoning and undesirable plants such as poison bean and water primrose were removed to a certain extent. The only fish left in the pond prior to stocking were mosquito fish. The pond was then stocked with 49 bluegill fingerlings and 17 largemouth bass fingerlings. During the course of one year the bass grew to approximately one pound each, but did not spawn. In contrast, the bluegills spawned in less than 8 months and continued to do so through the winter and spring.

BONNEAU, D. L. and J. M. CONLEY. 1972. A summary of largemouth bass management in the Midwest. p. 6-9 *In* J. L. Funk [ed.]. Symposium on Overharvest and Management of Largemouth Bass in Small Impoundments. American Fisheries Society Special Publication No. 3. Bethesda, Maryland.

Largemouth bass are the major predators of many Midwestern sport fisheries. Problems common to the Midwest prompted a survey of the policies and regulations governing the management of this species. This paper summarizes those findings.

The fish stocking practices of the many Midwestern states and Ontario, Canada were reviewed and bluegill-bass fingerling planting ratios (on a per acre basis) were discovered to be as follows:

- Illinois – 50-100 bass and 50-1,000 bluegills or 150-300 redear sunfish
- Iowa – 100-200 bass and 500-1,000 bluegills
- Indiana – 100 bass and 1,000 bluegills or redear sunfish
- Kansas – 100 bass and 50-100 bluegills
- Michigan – 150 bass and 500 bluegills or 500 hybrid sunfish
- Minnesota – 10-20 bass (number of forage fish not available)
- Missouri – 100 bass and 500 bluegills
- Nebraska – 100 bass and 150 bluegills
- North Dakota – 350 bass (number of forage fish not available)
- Ohio – 200 bass and 1,000 bluegills
- South Dakota – 100-200 bass and 300 bluegills
- Wisconsin – 400 bass (number of forage fish not available)

Several techniques have been used to regulate the harvest of bass, from closed seasons to size regulations. Overall, the survey indicated that the overharvest of largemouth bass was a problem in Illinois, Iowa, Indiana, Kansas, Michigan, Missouri, Nebraska, North and South Dakota and Ohio, and is partially responsible for poor quality fishing.

BORGESON, D. P. 1987. Fish stocking guidelines. Fisheries Management Report No. 11. Michigan State Department of Natural Resources. Lansing, Michigan. 32 p.

In Michigan the stocking of both smallmouth bass and largemouth bass is limited to new or reclaimed waters. The purpose of bass planting is typically to provide a new self-sustaining fishery. Because of rearing difficulties, smallmouth bass are only planted in waters where there has previously existed a population or where suitable habitat is available. In lakes which are moderately productive two plants of 40 bass fingerlings per acre should be carried out, the first occurring immediately following the chemical treatment of the water, and the next the following year. One pair of adults for every ten acres may be introduced when reproduction is low, however, fingerlings are always preferred to adults when stocking because of doubts concerning their impact on year class strength.

There are numerous suggested stocking combinations for warmwater fish in the absence of predators:

- 640 bluegill fingerlings and 40 largemouth bass fingerlings per acre;
- 640 bluegill fingerlings, 30 largemouth bass fingerlings, and 200 northern pike fry per acre;
- 400 bluegill fingerlings, 30 largemouth bass fingerlings, 200 northern pike fry, 60 fingerling channel catfish, and 0.2 adult crappie per acre; 160 bluegill fingerlings, 30 smallmouth bass fingerlings and either 800 walleye fry or 50 walleye fingerlings per acre.

BOTTROFF, L. J. 1967. Intergradation of Florida bass in San Diego County, California. Master's Thesis, San Diego College. San Diego, California.

BOTTROFF, L. J. and M. E. LEMBECK. 1978. Fishery trends in reservoirs of San Diego County, California, following the introduction of Florida largemouth bass (*Micropterus salmoides floridanus*). California Fish and Game 64(1) : 4-23.

The impact of Florida bass introductions in four San Diego County, California reservoirs (El Capitan, Sutherland, San Vincente, and Lower Otay) was evaluated from 1965 through 1976. Florida bass hybridized with resident northern stocks in all test waters. Bass populations rapidly assumed Florida-like characteristics at Sutherland and Lower Otay reservoirs and a similar, although less complete, transition occurred at San Vincente Reservoir. By contrast, the bass population at El Capitan Reservoir has remained in a comparatively stable hybridized state for a number of years. Northern bass grew slightly faster than Florida bass during their first year of life. In subsequent years, Florida bass grew at substantially faster rates. Florida bass are less vulnerable to angling than northern or hybrid bass and populations with Florida-like characteristics are resistant to overharvest by anglers. The mean size of bass caught and the incidence of trophy specimens has increased in reservoirs where Florida bass have been established. Increased bass yields were associated largely with the development of hybridized populations although one impoundment containing bass with Florida-like characteristics provides angling of exceptional quality. Bluegill yields have declined markedly in reservoirs where Florida bass were introduced.

BOUCHER, D. P. 1993. Exploitation of smallmouth bass in a small Maine Lake. p. 10 *In* Managing Black Bass in Northern Waters. Northeast Division of American Fisheries Society Warmwater Workshop, October 5-6, 1993, Alexandria Bay, New York. (Abstract only)

Fishing effort for smallmouth bass (*Micropterus dolomieu*) has increased dramatically in Maine, as have angler complaints of declining fish quality. This study utilized voluntary returns of tagged fish to obtain estimates of angling exploitation on smallmouth bass in Brettun's Pond, a 165 acre (67 ha) mesotrophic water in central Maine. A total of 173 jaw-tagged smallmouth bass was released into Brettun's Pond in late May 1990. Of 34 tagged bass reported during a one year period, 53% were creeled, 47% were released, and the disposition of two fish was not reported. The minimum exploitation rate was 0.10. Adjustment for non-reporting suggested an actual exploitation rate of 0.25. Minimum potential exploitation rate, the rate that would have occurred had anglers creeled all tagged bass they caught, was 0.20. Potential exploitation adjusted for non-reporting was estimated to be 0.49. Similar exploitation rates in New York waters produced declines in size quality. Existing levels of bass fishing effort may be negatively impacting bass size quality in some Maine waters.

BOUDREAU, T. A. 1987. Largemouth bass introductions made in the Parry Sound District 1987. File Report. Ontario Ministry of Natural Resources. Parry Sound, Ontario.

From September 9-24, 1987, a total of 562 sub-adult and adult largemouth bass (*Micropterus salmoides*) ranging in size from 225 grams to 3100 grams were transferred to Axe Lake (Monteith Township) from 4 lakes in the Parry Sound District. One hundred and forty-six (146) largemouth bass were captured from Bear Lake (Monteith Township), 163 from Rainy Lake (Ryerson Township), 84 from Sugar Lake (Christie Township) and 169 from Gooseneck Lake (Burton Township). The fish from Bear Lake were the smallest, those from Gooseneck the largest.

BOWEN, J. T. 1970. A history of fish culture as related to the development of fishery programs. p. 71-94 *In* N. G. Benson [ed.]. A Century of Fisheries in North America. American Fisheries Society. Bethesda, Maryland.

In the early days of fish stocking the largemouth and smallmouth bass were introduced with little distinction being made between the two species. In 1969 the Connecticut Fish Commission began to stock bass and by the following year bass had been introduced into five New England states. Bass transplantation also occurred as they were transported by train from the Ohio River to the Potomac River in 1954. Private citizens are suspected of introducing the bass into the Susquehanna River in Pennsylvania in 1969. Bass were hailed as a species which easily adapted to new surroundings and they were extensively propagated for stocking purposes. Transfers between waterbodies also became a common occurrence.

BOWMAN, D. W. 1993. Distribution and abundance of reintroduced smallmouth bass and native largemouth bass and spotted bass in relation to water quality in Beaver Reservoir. Arkansas-Oklahoma Chapters of the American Fisheries Society Joint Annual Meeting, February 16-18, 1993, Fort Smith, Arkansas. (Abstract only)

Water quality parameters known to affect smallmouth bass populations were measured longitudinally in Beaver Reservoir to assess suitable habitat. Electrofishing was used to find trends in black bass populations related to trends in water quality. Upper Beaver Reservoir was found to be turbid, productive, eutrophic, and contained poor smallmouth bass habitat. Lower Beaver Reservoir was found to be clear, oligotrophic, and excellent smallmouth bass habitat. Mid-Beaver Reservoir was found to be a mesotrophic transition zone that may be poor to good smallmouth bass habitat depending on the season and reservoir inflow. Largemouth bass and spotted bass electrofishing catch rates were positively correlated with reservoir productivity. Smallmouth bass population displayed a very restricted population centered around the point of stocking (Beaver Nursery Pond) and showed a weak negative correlation with reservoir productivity.

BOWMAN, D. W. 1994. Distribution and abundance of reintroduced smallmouth bass in relation to water quality in Beaver Reservoir, Arkansas. *In* the Southern Division of the American Fisheries Society Mid-Year Technical Session, February 26-March 1, 1994, Little Rock, Arkansas. (Abstract only)

Potential habitat for, and current status of, a recently reintroduced smallmouth bass population was investigated in Beaver Reservoir. Beaver Reservoir compared favorably to the Buynak et al. (1991) model for reservoir characteristics necessary to support smallmouth bass. Longitudinally, within the reservoir, smallmouth bass habitat varied. The up-lake area is eutrophic and therefore, not smallmouth bass habitat. The down-lake area is oligotrophic and of excellent smallmouth bass habitat, while the mid-lake area is a mesotrophic transition zone that provides adequate smallmouth bass habitat. In Autumn 1991 and Spring 1992 electrofishing samples, smallmouth bass made up 10% (N = 166) and 5% (N = 84), respectively, of the overall black bass catch. Smallmouth bass were not captured in the up-lake electrofishing samples and only 0.8% (N = 2) of the overall total smallmouth bass catch were taken in the down-lake electrofishing samples. The other 99.2% (N =248) of the total smallmouth bass catch was in the mid-lake area of the reservoir with the highest catch rates occurring in the immediate area surrounding the Beaver Nursery Pond from which the smallmouth bass were stocked.

BOXRUCKER, J. C. 1982_a. Mass marking of fingerling largemouth bass by fin-clipping followed by freeze-cauterization of the wound. North American Journal of Fisheries Management 2(1) : 94-96.

An estimated 162,828 fingerling largemouth bass (*Micropterus salmoides*) were marked in 153 man-days (1,064 fish per man-day) by a combination of fin-clipping followed by freeze-cauterization of the wound with liquid nitrogen. This technique provided an easily identifiable mark that can be applied to small fish. Instantaneous mortality was negligible and delayed mortality (1 week) resulting from marking and handling was estimated to be 17.1%.

BOXRUCKER, J. C. 1982_b. First year growth and survival of stocked largemouth bass in a small Oklahoma impoundment. Proceedings of the Annual Conference of Southeastern Association of Fish and Wildlife Agencies 36 : 369-376.

Liberty Lake was stocked with fingerling largemouth bass (*Micropterus salmoides*) at 448/ha in July, 1980. Monthly electrofishing samples collected for 1 year following stocking showed 76.4% of the 1980-year-class to have been stocked. A bimodal length distribution of stocked fish appeared in fall, 1980 and continued throughout the sampling period. Decreased survival of the stocked largemouth bass during the winter was noted. Most mortality occurred in the slower growing fish. However, a decline in the number of fish from both length modes was evident.

BOXRUCKER, J. C. 1986. Evaluation of supplemental stocking on largemouth bass as a management tool in small impoundments. North American Journal of Fisheries Management 6 : 391-397.

Largemouth bass (*Micropterus salmoides*) fingerlings (35-64 mm total length) were supplementally stocked into two small Oklahoma impoundments, Liberty Lake and Wiley Post Lake, in July 1980 at a density of 450/hectare to enhance year class strength. Stocked fish constituted 76 and 72% of the 1980 year class in Liberty and Wiley Post lakes, respectively, for two growing seasons following stocking. Natural mortality at age 1+ appeared to drastically reduce the numbers of stocked fish. The stocked largemouth bass reached quality length (300 mm) toward the end of the third growing season and made up 3 and 17% of the quality length fish in the 1983 electrofishing samples from Liberty and Wiley Post lakes, respectively. Creel data indicated that angler catches and harvest rates were unaffected by the stocking program.

BRAUN, E. R. 1987. Survival of 5- to 11-inch supplementally stocked largemouth bass. Completion Report. Indiana Department of Natural Resources. Indianapolis, Indiana.

BROCK, V. E. 1960. The introduction of aquatic animals into Hawaiian waters. Internationale Revue der Gesamten Hydrobiologie 45 : 463-480.

BROOKS, J. E. 1980. The status of the black bass fishery in Lake Mead and a program toward restoration and enhancement. Arizona Fish and Game Department. Phoenix, Arizona. 79 p.

The reporting period for the second year of the black bass study on Lake Mead was October 1, 1978 to December 31, 1979. A food organism study and evaluation of stocking marked hatchery-reared largemouth bass was initiated.

Cover inventory was taken at the four stations where the black bass nesting was monitored. The 367 m elevation maximized available cover.

A vegetative study, that monitored the growth of aquatic vegetation, was conducted for three months.

Nesting success for 1979 was 37.5%. Nesting activity occurred from March 31 to May 9. Water level fluctuation appeared to have no effect on nesting success.
The invertebrate food organisms study did not show a significant difference in numbers of organisms for various cover types and depths.

Relative abundance of young of the year bass in September was 34.8%. That amount is less than the 59% reported for 1978. Hatchery-reared largemouth bass (5-15 cm in length) were marked with fluorescent granular pigment. Two-fifths of the total number marked were stocked in the Arizona study area. Approximately 51,000 hatchery bass (5-10 cm) were marked with the yellow fluorescent paint and were in poor condition and experienced high mortality rates. In contrast, the 22,600 hatchery bass (10-15 cm) marked with yellow-red pigment experienced low mortality and were in good condition. Black bass contributed less to the total catch in 1979 than 1978 (17.7% versus 55.7%), likely due to the increase in striped bass.

BROWN, C. J. D. and N. A. THORESON. 1951. Ranch fish ponds in Montana. Journal of Wildlife Management 16(3) : 275-278.

There are over 40,000 small ranch ponds in Montana. Past records demonstrate that a variety of fish species have been planted in Montana ponds, such as trout, bass, bluegills, crappies, bullheads, shiners, pike, minnows and walleye. On the basis of investigations completed, recommendations have been made for both fish pond construction and management. The following are some of the most important suggestions, which we feel are necessary attributes for a successful pond.

- Construction of the pond should be completed so that there is little chance of bank erosion. Grading and fencing is recommended as well as a drain outlet.
- One fifth of the pond should be at least ten feet deep when water is at its lowest to provide fish with enough oxygen to survive the winter and the area should be at least one-quarter acre and at least two if the pond is intended for community fishing.

Warmwater ponds are currently recommended for bass and bluegill stocking although the authors feel that this combination is unsuitable for the Montana climate, as the growing season is too short for good growth. If this combination is planted the recommended ratio is 1:5 bass to bluegills per acre (typically 100:500). Fertilization of warmwater ponds has demonstrated no positive benefits in Montana.

The Montana Fish and Game Department is currently conducting numerous warmwater experiments involving the stocking ratios and combinations of such species as western sauger, channel catfish, largemouth bass, bluegill and black crappie.

BROWN, E. H., Jr. 1961. Movement of native and hatchery-reared game fish in a warmwater stream. Transactions of the American Fisheries Society 90 : 449-456.

Movement of 248 marked and recaptured native smallmouth bass (*Micropterus dolomieui*), native rock bass (*Ambloplites rupestris*) and hatchery smallmouth bass released in a headwater tributary of the Little

Miami River of Ohio during 1953 through 1957 is described. More than 91% of the native fishes of both species reported by anglers were taken within 1/2 mile of release points. Recaptures made with electric shockers and hoop nets indicated that appreciable numbers of native fish remained within limited areas of one to several pools between successive years. Considerable numbers of stocked smallmouth bass moved away from release points. A total of 35.7% of fish stocked in optimum habitat in 1953 and later recovered by anglers had moved distances greater than 1/2 mile. All fish stocked in submarginal habitat upstream in 1955 and later recovered by anglers moved more than 1/2 mile. Except for one recapture 6 miles upstream from the release point, all returns of stocked fish were from downstream at distances of up to 70 miles. The proportion of fish stocked in optimum habitat in 1953 and recaptured 11 to 50 miles downstream increased significantly from 1953 to 1954, suggesting a progressive downstream dispersal. Movement of hatchery smallmouth bass was independent of size at stocking in 1953. Rapid disappearance of the 1953 stocked fish may have resulted from higher mortality as well as from movement.

BROWN, M. L. and B. R. MURPHY. 1994. Temporal genetic structure of an intergrade largemouth bass (*Micropterus salmoides*) population. Ecology of Freshwater Fish 3(1) : 18-24.

Since 1972, numerous impoundments throughout Texas have been stocked with Florida largemouth bass (*Micropterus salmoides floridanus*). In order to examine some of the long-term effects of such efforts, the present study summarizes past studies and complements those with more current observations on the intergrade largemouth bass population in Aquilla Lake, Hill County, Texas. The reservoir received 4 annual stockings during the month of May from 1982 to 1985. Collections occurred periodically from February 1984 to June 1987, February to August 1988, and monthly from August 1991 to November 1992. Horizontal starch-gel electrophoresis was conducted to determine allele frequencies at loci sAAT-B*, sIDHP* and SSOD of liver enzymes aspartate aminotransferase, isocitrate dehydrogenase and superoxide dismutase, respectively. Frequencies of alleles associated with the Florida phenotype (i.e., electrophoretic phenotype) generally increased across year classes and over time for specific year classes, although fewer significant differences were observed between year-class allele frequencies during the post-stocking period than during the stocking period. Frequency of the sSOD**1* allele increased linearly across the study period. Linear relationships among Florida allele frequencies were significant and well correlated, except for sAAT-B*3 and sAAT-B*4, and sAAT-B*4 and sSOD**1*. Mean heterzygosity and percent introgression were highest for age-0 fish of the 1986 year class. Assortive mating was not apparent in 1991 or 1992 year classes. Collections of specific year classes over time consistently indicated decreases in the relative abundance of the northern phenotype, the abundance of Florida year classes remained relatively constant over time. Relative abundances of F_1 hybrids and F_x intergrades (i.e., $F >_1$) from specific year classes were observed to generally increase with age.

BROWN, M. W. 1939. Smallmouth black bass propagation in California. Transactions of the American Fisheries Society 69 : 119-124.

This paper traces very briefly the history of the smallmouth black bass in the State of California from the time of its introduction to the present day. The Central Valleys Bass Hatchery, recently constructed near Sacramento, California, is described. Methods and results of the propagation of smallmouth black bass are reviewed in an account of the operations in the 1938 season at this new California bass hatchery.

BROWN, P. J., D. C. JOSEPHSON and C. C. KRUEGER. 2000. Summer habitat use by introduced smallmouth bass in an oligotrophic Adirondack lake. Journal of Freshwater Ecology 15(2) : 135-144.

Non-native smallmouth bass became established in 1951 in Little Moose Lake, an oligotrophic Adirondack lake. Salmonids dominated the littoral zone at the time. Snorkel surveys, from late June through early August 1997, were used to determine the distribution and abundance of fish in the littoral zone. Transects were established on four habitat types: sand, wood (submerged trees), rock covered by silt (particles < 2 mm), and clean cobble (particles > 64 mm). Non-native smallmouth bass were the most common fish species observed over the transects. Counts of adult smallmouth bass (*Micropterus dolomieu*) were greater than pumpkinseed (*Lepomis gibbosus*) and salmonids. Average lengths of bass were different between habitat types indicating size class segregation among the habitats in the littoral zone. Adult bass (> 50 mm) were only observed on wood and cobble habitats. Nearly all bass > 300 mm were observed on wood habitats. Young-of-the-year bass (< 50 mm) were only observed on sand and silted rock. Only two brook trout (*Salvelinus fontinalis*) and three rainbow trout (*Oncorhynchus mykiss*) were observed; however, water temperature (range 21°C to 24°C) may have limited their presence. We conclude that non-native smallmouth bass dominate the littoral zone of this Adirondack lake during the summer.

BROWN, W. H. 1951. Results of stocking largemouth black bass and channel catfish in experimental Texas farm ponds. Transactions of the American Fisheries Society 80 : 210-217.

Twenty-two experimental farm ponds were operated at the A. E. Wood State Fish Hatchery, San Marcos, Texas, during the period 1948-50. Various stocking ratios and species combinations were employed for both fry and fingerlings of largemouth black bass (*Micropterus salmoides*), and fingerling channel catfish (*Ictalurus lacustris*). Forage fish including bluegill (*Lepomis macrochirus*), redear (*Lepomis microlophus*), and yellow belly (*Lepomis auritus*) sunfish were used in these combinations. Black crappie (*Pomoxis nigromaculatus*) were stocked in two ponds. Ponds were compared on basis of pounds per acre per year. High production in total pounds of edible fish was not dependent on stocking ratio alone: 50 catfish, 100 bluegill, and 50 crappie per acre (152.4 pounds), 100 catfish only (116.2 pounds), 100 bass fingerlings and 1,500 bluegill (100.3 pounds), 100 bass fingerlings, 100 bluegill and 50 crappie (96.4 pounds), and 250 bass fingerlings only per acre (94.1 pounds) were high combinations. Fertilization increased the total production of edible fish in bass-bluegill combinations.

Yields from bass-bluegill ponds indicate that the weight of edible bass per acre is decreased as the stocking ratio of bluegill is increased. Average weight of adult bass was found to vary inversely with survival rate of fingerlings. Average weight of adult bluegill was found to vary inversely with number stocked. Results from bass fry ponds indicate that ratios of 200 to 400 bass fry only per acre produce the greatest weight of edible bass but bass fry-sunfish combinations produce bass with greater individual weights. Yields from all ponds suggest that channel catfish afford a higher poundage of edible fish per acre per year than any other species stocked.

BROWN, W. H. 1952. Rate of survival of largemouth black bass fry stocked in experimental farm ponds. Progressive Fish Culturist 14 : 79-80.

The results from eight experimental ponds located at the A. E. Wood State Fish Hatchery in San Marcos, Texas are presented. Between 1948 and 1950 stocking experiments were carried out to determine the survival rate of stocked largemouth black bass fingerlings without fishing pressure. Largemouth bass were stocked as fingerlings in combination with bluegills and black crappies and alone. At the end of 18 months survival rates of the largemouth bass ranged from 47.1 to 83.8%, with an average of 65%. This figure is close to that obtained in Texas farm ponds when no fishing pressure is being applied. The bass-bluegill combination gave the highest survival rate (of 83.3%) with two stocking combinations: 125 bass and 1,000 bluegills per acre, and 125 bass and 500 bluegills per acre. Bass stocked alone (at 250 per acre) had a 69% survival rate. All three species combined (100 bass, 100 bluegills and 50 black crappie per acre) gave the poorest results with only a 47.1% survival rate for the largemouth bass. It is suspected that the overall survival rate can be raised if fishing is allowed directly after fish stocking.

BRUNSON, M. W. and H. R. ROBINETTE. 1986. Evaluation of male bluegill x female green sunfish hybrids for stocking Mississippi farm ponds. North American Journal of Fisheries Management 6(2) : 156-167.

Supplemental feeding and the presence of largemouth bass (*Micropterus salmoides*) had a positive influence on the size of male bluegill (*Lepomis macrochirus*) x female green sunfish (*Lepomis cyanellus*) hybrids in 12 Mississippi ponds during the first 24 months after stocking young-of-the-year hybrids and bass. After 24 months, the size of hybrids that had supplemental feeding and were stocked without largemouth bass was similar to that of hybrids stocked with largemouth bass but without supplemental feeding. Nonfed hybrids stocked without largemouth bass were the smallest of the four group combinations; fed hybrids with largemouth bass were the largest. Largemouth bass predation reduced recruitment of F_2 hybrids by 98% relative to F_1 hybrid populations without bass. Growth of these hybrids exceeded that reported for the same hybrid in Illinois ponds and was superior to that which can be expected from bluegills under typical pond conditions in Mississippi. Catchability experiments in two of the ponds confirmed the aggressive behavior of the hybrids. On one pond, during 10 angler-hours of fishing with each of three bait types, hybrids were caught most frequently with live worms (16.5 fish/h), followed by artificial spinner baits (9.5 fish/h) and dry flies (3.6 fish/h). This pond and one other were subjected to intensive angling for 2 h each. Twenty-one percent and 66% percent of the fish were captured by hook and line on a variety of baits during 12 and 18 h of angling, respectively.

BRYNILDSON, C. L. and J. R. TRUOGG. 1959. Fish management of Wisconsin farm ponds. Wisconsin Conservation Bulletin 24(11) : 27-30.

This article is presented as answers to frequently asked questions concerning private pond management. If water temperatures are too high for trout it is recommended that only largemouth bass be stocked. The stocking of largemouth bass and bluegills does not have a high success rate in Wisconsin as in the southern United States. The bluegills tend to become overabundant making for poor fishing. If bluegills must be stocked wait one to two years after stocking the largemouth bass before introducing them.

BUCK, D. H., R. J. BAUR and C. R. ROSE. 1974. Interactions of intensive cultures of channel catfish with largemouth bass and bluegills in 1-acre ponds. Illinois Natural History Survey Biological Notes 84. Starkville, Illinois. 8 p.

BUCK, D. H. and M. L. HOOE. 1986. Comparative growth of Northern largemouth bass and F_1 hybrid largemouth bass through three growing seasons. Transactions of the American Fisheries Society 115(2) : 296-304.

A 3-year study was conducted of growth and condition of northern largemouth bass (*Micropterus salmoides salmoides*) and F_1 hybrid largemouth bass (male northern smallmouth bass (*M. dolomieui dolomieui*) x female largemouth bass) stocked together in diverse pond treatments. Six drainable 0.4-ha ponds in southern Illinois were initially stocked with similar numbers of half-sibling largemouth bass and F_1 hybrid larvae produced in the laboratory. Most populations were censused and restocked each spring and fall through three growing seasons (1979-1981). Supplementary data were generated by introducing age-1 largemouth bass and F_1 hybrids into two larger ponds containing mature populations dominated by largemouth bass and bluegills. Growth of pure largemouth bass was significantly faster than that of half-sibling F_1 hybrids in all populations studied each year, regardless treatment, although third-year growths in the 0.4-ha ponds were complicated by a differential response to tagging. After the initial stocks of pure and F_1 hybrid bass reached age 1, samples of their pond-spawned, age-0 progeny were subjected to starch gel electrophoresis to distinguish pure largemouth bass from those containing smallmouth bass alleles (F_2 and backcrossed individuals). In all cases, growth by the pure age-0 largemouth bass was equal to or significantly greater than that by fish having smallmouth bass alleles ($P < 0.05$).

BUCKMEIER, D. L. and R. K. BETSILL. 2000. Stocked largemouth bass fingerlings: Their survival, dispersal and influence on resident young-of-year. Paper presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

Florida largemouth bass (*Micropterus salmoides floridanus*) were tagged and stocked into 9 coves within a 500-ha embayment of O. H. Ivie reservoir, Texas (7,776 ha) to evaluate dispersal and survival of stocked fish and effects on abundance and survival of resident young-of-year largemouth bass. After 7 days, 93% of recaptured fish were within 850 m of stocking points; after 34 days, the proportion had stabilized at about 80%. Poststocking survival of fish held in cages for 24 h (N = 270) was 100% in all stocked coves. Although initial densities of stocked fish were equal they varied greatly among stocked coves after 7 days indicating substantial differences in short-term survival. Coves with high survival (N = 4) showed evidence of increased mortality of resident young-of-year fish between 7 and 34 days, while coves with low survival (N = 5) had temporal patterns of abundance similar to those in unstocked coves. Mortality of stocked fish estimated for the entire embayment from 7-153 days poststocking was 2.4%/day ($r^2 = 0.983$; $P < 0.0001$). At 153 days, stocked fish made up about 8% of the year class within stocked coves and 3% in the embayment. Stocking largemouth bass did not increase the abundance of young-of-year within the embayment and stocked fish apparently displaced resident fish, as densities did not differ between stocked and unstocked coves.

BULAK, J., J. LEITNER, T. HILBISH and R. A. DUNHAM. 1995. p. 226-23 *In* H. L. Schramm, Jr. and R. G. Piper [eds.]. Uses and Effects of Cultured Fishes in Aquatic Ecosystems. American Fisheries Society Symposium 15. Bethesda, Maryland.

A statewide allozyme survey of largemouth bass (*Micropterus salmoides*) was performed in South Carolina to characterize the relative abundance of alleles characteristic of the northern and Florida subspecies. Data confirmed that South Carolina is part of a broad hybrid zone between the two subspecies. The frequency of alleles that are fixed for the Florida subspecies ranged from 98% in Lake Moultrie, a southeastern site, to 36% in Lake Wateree, a north-central site. The existence of geographically dependent allelic clines and the dependence of allele frequency on location and gene locus suggests that, in South Carolina, the hybrid zone is maintained by a balance between gene flow and selection. Analysis of the Lake Wateree population, near the center of the hybrid zone failed to detect any linkage disequilibrium between the four loci that were tested. The absence of linkage disequilibrium and the lack of coincidence among clines at different loci suggests that this hybrid zone is not a tension zone but probably results from an environmental selective gradient across South Carolina.

The survey also provided preliminary evidence of a size-based allele selection in Lake Wateree and a suggestion that selection may modify allele frequencies within the State's hatcheries. Allele frequencies in the South Carolina hatchery system were significantly different from natural populations in the warmest and coldest areas of the state. Current hatchery practices include a semidomesticated broodstock and random selection of stocking sites for each hatchery. The regionalization of hatchery brood stocks to maximize fitness was suggested from this survey. In a vision of this strategy, broodstock with a high percentage of Florida alleles would be stocked in the warmer regions of the state. Conversely, largemouth bass with a higher percentage of northern alleles would be stocked in the cooler regions. From a genetic perspective, the decision to transfer stocks should largely rest on the fitness of a specific phenotype within a defined area.

BURLEY, B. 1978. Tagging project of largemouth bass on Temperance Lake. Ontario Ministry of Natural Resources. Brockville, Ontario. 3 p. + appendices.

A tagging project was initiated on Temperance Lake based on complaints that the largemouth bass in the lake were stunted. Planting has occurred in the past and the final planting consisted of 2,000 fingerling bass in 1967. The bass were found to be stunted. Possible solutions to this problem include removal of other fish species. The transfer of the bass to another lake is not favoured at this time.

BURNLEY, T. W. 1994. Wild and hatchery-reared largemouth bass, *Micropterus salmoides*: Condition factor in four small Arkansas lakes and habitat selection comparisons. M. Sc. Thesis, University of Arkansas, Arkansas Cooperative Research Unit Publication 23. Fayetteville, Arkansas. 78 p.

BURRESS, R. M. 1949. The growth rates of bluegill and largemouth bass in fertilized and unfertilized ponds in central Missouri. Master of Arts Thesis, University of Missouri. Columbia, Missouri. 79 p.

BURRESS, R. M. 1951. Findings of the survey of ponds stocked with bass in the summer and bluegills in the fall, 1949. Missouri Department of Conservation. Jefferson City, Missouri. 3 p.

BURRESS, R. M. 1953_a. A study to determine the effect of reversing the order of stocking of bass and bluegills on the growth rate and composition of their populations. Project No. 312, Final Report. Missouri Department of Conservation. Jefferson City, Missouri. 6 p.

BURRESS, R. M. 1953_b. Results of the survey of ponds stocked with bass in the summer and bluegills in the fall, 1949. Missouri Department of Conservation. Jefferson City, Missouri.

BURRESS, R. M. and G. F. WEISS. 1952. A study of largemouth bass-bluegill stocking rates and ratios in ponds. Project No. 310, Final Report. Missouri Department of Conservation. Jefferson City, Missouri. 13 p.

BUYNAK, G. L. 1985. Applications of largemouth bass remedial stockings in small impoundments in Kentucky. Fisheries Bulletin No. 73, Kentucky Department of Fish and Wildlife Resources. Frankfort, Kentucky. 39 p.

Largemouth bass were remedially stocked in three small impoundments in an attempt to improve the population structure of largemouth bass. This study was performed to determine where remedial stocking has application. Largemouth bass populations in Guist Creek Lake and Fishpond Lake showed improvements as a result of stocking. At Cannon Creek Lake, the stocking of large numbers of advanced fingerlings did little, if anything, to improve the size structure of the bass population. Stocking of largemouth bass in an infertile (oligotrophic) lake, like Cannon Creek Lake, does not appear to improve the black bass size structure. In these lakes, the stocking of smallmouth bass may be an appropriate management option if suitable coldwater habitat exists. If the management decision is not to establish a self-sustaining population of smallmouth bass because of lack of habitat or the lake is too small (approximately 100 acres or less), the lake may be fertilized to improve largemouth bass habitat followed by stockings of bass. This approach was effective at Fishpond Lake. In more fertile (mesotrophic or eutrophic) lakes where largemouth bass habitat is not limited, remedial stocking can improve the bass size structure, as occurred at Guist Creek Lake, if the problem causing the imbalance cannot be corrected by methods other than stocking.

BUYNAK, G. L. 1986. Smallmouth bass stocking evaluation at Herrington Lake. Fisheries Bulletin 79. Kentucky Department of Fish and Wildlife. Frankfort, Kentucky. 14 p.

A total of 561,334 smallmouth bass ranging in length from fry to 3.5 inches were stocked into Herrington Lake from 1978-1981 in an attempt at re-establishing smallmouth bass in the lake. For the first year of impoundment, a self-sustaining smallmouth bass fishery existed in the lake. Cover rotenone data collected from 1948 through 1955 indicated that a viable smallmouth bass population existed during these years. After 1955, only one fingerling-sized (5 inches) smallmouth bass was taken in 1961 and one harvestable-sized (> 10 inches) smallmouth bass was collected in 1976. A selective shad removal program conducted from 1956-1959 was at one time thought to be responsible in part for the elimination of smallmouth bass from Herrington Lake.

Results of this evaluation study of the smallmouth bass stocking showed that a self-sustaining fishery did not result from the stocking of large numbers of smallmouth bass into the lake. During the four years of stocking, smallmouth bass made up a mean of only 0.9% of the total number and 0.7% of the total weight of bass collected during cover rotenone studies. No smallmouth bass of any size were collected in rotenone studies from 1982-1985. Creel survey data collected from 1980 through 1984 indicated that some of the stocked smallmouth bass did survive, grow, and contribute to the creel. Stocked smallmouth bass accounted for a mean of 1.3% of the total number and 1.1% of the total weight of bass harvested in these years. For a smallmouth bass stocking program to be considered a success at developing a self-sustaining fishery, this species is expected to contribute about 10% to the black bass biomass and/or 10% of the yield of all bass. Little, if any, reproduction success from the 1982 year class was evident from the 1985 creel survey results to indicate that the stocked fish have developed a viable self-sustaining population.

The apparent reason for both the elimination of smallmouth bass from the lake in the 1950s and the failure at re-establishing the smallmouth bass fishery is a result of eutrophication and the gradual reduction and subsequent elimination of coolwater habitat suitable for smallmouth bass in the lake.

BUYNAK, G. L. 1995. Evaluation of a smallmouth bass stocking program at Cave Run and Cannon Creek lakes. Fisheries Bulletin No. 97. Kentucky Department of Fish and Wildlife Resources. Frankfort, Kentucky.

Self-sustaining populations of smallmouth bass (*Micropterus dolomieu*) developed at both Cave Run and Cannon Creek lakes following a three year stocking program. Both of these tributary reservoirs contained lake habitat characteristics necessary for viable smallmouth bass populations. A total of 358,862 hatchery fingerlings (1.1-1.7 in) and 1,535 hatchery fingerlings (5.9-14.1 in) were stocked in Cave Run Lake from 1985-1987, while 26,233 fingerlings (1.5-2.5 in) were stocked at Cannon Creek Lake from 1982-1984. Natural reproduction was documented at each lake, in each year sampled, since stocking was completed. In 1992 and 1993, smallmouth bass accounted for 20.0 and 37.4% of the black bass observed by divers at Cannon Creek Lake. At Cave Run Lake, from 1992-1994, smallmouth bass accounted for 7.4-13.2% of the total number and 6.7-14.5% of the total weight of the black bass collected in cove rotenone studies. The highest standing stock estimate of 2.0 lb/acre was taken in 1994. Electrofishing catch rates of smallmouth bass since 1990 have ranged from 7.8-13.9 fish/hour for all samples taken at the lake with higher densities collected in the lower and mid-lake sections. Smallmouth bass accounted for 17.7% of the total number and 18.7% of the weight of black bass harvested at Cave Run Lake in 1994. The establishment of these self-sustaining smallmouth bass populations represents a fishery management option designed to utilize suitable reservoir habitat and provide the angler with a more diversified fishing opportunity.

BUYNAK, G. L., L. E. KORMAN, A. SURMONT and B. MITCHELL. 1991. Evaluation of a smallmouth bass stocking program in a Kentucky Reservoir. North American Journal of Fisheries Management 11(3) : 293-297.

Habitat characteristics of self-sustaining populations of smallmouth bass (*Micropterus dolomieu)* in Kentucky tributary reservoirs were used successfully to predict the potential for establishing a reproducing population in Cave Run Lake. Altogether, 358,862 hatchery fingerlings (1.1-1.7 in long) were stocked in Cave Run Lake from 1985 to 1987, along with 1,535 hatchery fish measuring 5.9-14.4 in. Fish spawned naturally each year from 1988-1990. In 1990 spring electrofishing collections, smallmouth bass constituted about 11.2% of all black bass (*Micropterus* spp.). The relative abundance of smallmouth bass was significantly greater (21% of all black bass) in the lower, oligotrophic area of the lake, where nine were collected. We concluded that (1) smallmouth bass habitat characteristics in the tributary reservoirs in Kentucky may be useful in identifying other reservoirs capable of supporting self-sustaining populations; (2) smallmouth bass, like striped bass (*Morone saxatilis*) and trout, are subject to summer stress when deprived of suitably oxygenated water at preferred temperatures; and (3) reservoirs with critical habitat should be protected from nutrient enrichment, which can eliminate optimal habitat.

BUYNAK, G. L. and B. MITCHELL. 1999. Contribution of stocked advanced fingerling largemouth bass to the population and fishery at Taylorsville Lake, Kentucky. North American Journal of Fisheries Management 19 : 494-503.

Fin-clipped largemouth bass (*Micropterus salmoides*) averaging 4.2-4.5 in long were stocked annually in 3,050-acre Taylorsville Lake in the fall from 1988 to 1992 at densities ranging from 9.8 to 27.8 fish/acre. Survival of each year-class of stocked largemouth bass from age-0 to age 5 was similar; however, survival from the time of stocking to fall collection varied among year-classes, which suggests density dependence in survival. Optimal stocking density ranged from 9.8 to 12.8 fish/acre based on higher survival and lower production costs. In 1993, after 5 years of stocking, the stocked largemouth bass accounted for 37.6% (< 8.0 in), 18.2% (8.0-11.9 in), 24.1% (12.0-14.9 in), and 14.9% (≥ 15 in) of the various size-groups and 24.5% of the total electrofishing catch. Contribution of the stocked largemouth bass in the electrofishing catch declined to below significant levels by the second spring after cessation of the fall stocking program. Corresponding significant increases were detected in the estimated anglers' catch and release of 8.0-11.9-in largemouth bass. Stocked largemouth bass accounted for an estimated 14.4% of the total number of 12.0-14.9-in fish and 11.5% of the total number of 15.0-in and larger fish caught and released by anglers from 1990 to 1995. Stocked largemouth bass did not result in significant increases in total numbers of bass harvested, however, they did account for 11.6% of the legal harvest of bass at the lake from 1990 to 1995. Contribution of stocked bass to the fishery declined rapidly after 1995, 3 years after stocking ceased. The 5-year largemouth bass stocking program at Taylorsville Lake provided benefits to both the population and fishery and resulted in a cost:benefit ratio of 1:3.9 for the catch-and-release portion of the fishery from 1990 to 1995.

BUYNAK, G. L., B. MITCHELL, D. MICHAELSON and K. FREY. 1999. Stocking subadult largemouth bass to meet angler expectations at Carr Creek Lake, Kentucky. North American Journal of Fisheries Management 19 : 1017-1027.

In response to angler dissatisfaction with the fishery for largemouth bass (*Micropterus salmoides*) at Carr Creek Lake, minimum length limits were increased in 1991 from 12.0 to 15.0 inches and pellet-reared subadult largemouth bass (mean length = 11.4-12.4 in) were stocked beginning in 1993. Anglers expected catch rates of 12.0 in and larger largemouth bass to increase from 0.24 to 1.18 fish hour^{-1} and harvest rates to increase from 0.01 to 0.06 fish hour^{-1}. Fin clipped largemouth bass were stocked during the fall of 1993 and 1994 and in the spring of 1996 and 1997 at densities of 9.9-10.2 fish acre^{-1}. The stocked largemouth bass resulted in an immediate increase in both the population and the catch-and-release portion of the angler's creel. Angler catch rates differed with the time of the year fish were stocked. Angler catch rate expectations were approached by spring stocking (1.01 fish hour^{-1}) but not from fall stocked fish (0.58 fish hour^{-1}). Harvest rates did not increase as a result of the stocking program. Survival of stocked largemouth bass was reduced by illegal harvest and by mortality from the catch and release of the highly vulnerable stocked bass. Stocked largemouth bass did not increase fish harvest, but did result in a cost:benefit ratio of 1:9 for the catch and release fishery. Stocking of subadult largemouth bass protected by a minimum length limit has angler catch and release benefits but subadult bass must be stocked annually for benefits to continue. Stocking programs such as this should be considered only for social reasons because long term improvements did not occur to either the fishery or the population.

BYRD, I. B. and D. D. MOSS. 1955. The production and management of Alabama's state-owned public fishing lakes. Transactions of the American Fisheries Society 85 : 208-216.

The construction of lakes by the State Department of Conservation was initiated to provide fishing in those areas having insufficient fishing waters. The lakes were constructed on carefully selected sites so that they could be managed for a maximum fish production. Efforts were made to eliminate all native fish from the streams, ponds, and pot-holes within the entire watershed in addition to those in the lake area prior to stocking with bluegill (*Lepomis macrochirus*), redear sunfish (*L. microlophus*), and largemouth bass (*Micropterus salmoides*). To keep these lakes in balance and producing high annual yields of fish, it was necessary to employ various management techniques, including fertilization, fish-population control, corrective restocking, and control of aquatic weeds and algae.

Alabama has 11 managed lakes containing a total of 591 acres that have been open to public fishing for 2 to 5 years. Three of the lakes, totaling 155 acres have been opened for 5 years, 3 containing 163 acres for 4 years, 1 with 40 acres for 3 years, and 4 containing 233 acres for 2 years. During the time that these lakes have been open, they have provided a total of 379,460 fisherman-trips in which the anglers caught a total of 1,291,012 fish weighing 364,062 pounds. These lakes, therefore, provided an annual average of 189 fisherman-trips per acre and an annual average catch of 642 fish weighing 180.9 pounds per acre. Although the lakes were subjected to extremely heavy fishing pressure, the average catch per fisherman-trip was 3.4 fish weighing 0.96 pound.

CARLANDER, K. D. 1952. Farm fish research in Iowa. Journal of Wildlife Management 16(3) : 258-261.

Most Iowa farm ponds are located in the southern half of the state where there is a lack of other fishing waters. Largemouth bass (*Micropterus salmoides*) and bluegills (*Lepomis macrochirus*) are typically the only species stocked. By sampling 111 ponds between 1948 and 1950, using the Swingle method, 56.8% were found to be in balance, 15.3% overpopulated with bluegills, 6.3% with bass, 19.8% with other species and 1.8% of ponds contained no fish.

Some of the ponds deemed to be overcrowded with bluegills have since been stocked with large fingerling and subadult bass from nearby ponds. It is unknown, as of yet, the level of success this supplemental stocking will have, but many bass have begun to establish themselves and reproduce. The full potential of these ponds has not yet been realized and currently the majority of the ponds offer less that 20 pounds per acre of annual harvest. It is suspected that increased fishing and tighter control of stunted forage fish populations could greatly increase the yield of the ponds.

CARLANDER, K. D. and R. B. MOORMAN. 1957. Some experiments in changing population balance in farm ponds. Progressive Fish Culturist 19 : 92-94.

While conducting farm pond studies in Marion County, Iowa, several attempts were made to improve the balance of the pond through stocking. Prior to this present study, additional stockings of bluegills, largemouth bass or both were made. Further attempts, using fish from nearby ponds, were made to bring experimental ponds into balance. Fingerling and yearling bass were used. The majority of these efforts failed, likely for the same reasons the initial stockings did. It is suspected that these ponds are too susceptible to winterkill conditions to sustain bluegill-largemouth bass populations.

CARMICHAEL, G. J. 1984. Long distance truck transport of intensively reared largemouth bass. Progressive Fish Culturist 46(2) : 111-115.

Five lots of advanced fingerling largemouth bass (*Micropterus salmoides*) shipped from the San Marcos Fish Hatchery and Technology Center in 1981 were in transit for 30 hours or longer. Three of the five lots were successfully transported; nearly all fish of the other two lots died. It appears that the weight per unit volume suitable for shipment of largemouth bass about 12.7 cm long is less than that for fish 20.3 cm long. Blood samples from fish in one successful shipment showed that plasma corticosteroid and plasma glucose levels, remained high for 24 hours after transport, and that plasma chloride continued to decrease for 24 hours after transport. Plasma chloride returned to nearly normal levels after 63 hours. Advanced largemouth bass fingerlings seemed to require a substantial acclimatization period of 64 hours or more to recover from long periods in transit. When the fish were not permitted to recover completely, a second, normally nonfatal, stressful occurrence, was fatal.

CARMICHAEL, G. J., G. A. WEDEMEYER, J. P. McCRAREN and J. L. MILLARD. 1983. Physiological effects of handling and hauling stress on smallmouth bass. Progressive Fish Culturist 45 : 110-113.

Mortalities associated with the handling and transporting of fishes have long been a problem. Research into physiological stress and its effects on smallmouth bass (*Micropterus dolomieui*) is needed in order to improve transfers of the fish between hatchery and stocking site. In this study plasma chloride, sodium, potassium, and glucose dynamics were monitored during transport and handling to determine the levels of stress experienced and the period of recovery.

Two handling trials were run. The first consisted solely of the transfer of smallmouth bass (of mean length 250.7 mm) from an outdoor raceways to an indoor tank. The second included 2.5 hours of transportation time. It was found that plasma glucose concentrations increased quickly after handling and hauling. Plasma chloride levels remained low, longer than 5 days following the move, and sodium levels remained depressed.

The initial levels of plasma glucose were higher than those reported for salmonids. Because many fish had not yet recovered from the handling and hauling five days following the incident, it is likely that the smallmouth bass are more fragile than first thought and further study as to their condition following transport to the stocking site is needed.

CARNES, W. C. 1960. Investigation of experimentally stocked farm ponds. Dingell-Johnson Project NC F-5-R-7, Job No. 2. North Carolina Wildlife Research Commission. Raleigh, North Carolina. 49 p.

CARPENTER, S. R., J. F. KITCHELL, J. R. HODGSON, P. A. COCHRAN, J. J. ELSER, M. M. ELSER, D. M. LODGE, D. KRETCHMER and X. HE. 1987. Regulation of lake primary productivity by food web structure. Ecology 68(6) : 1863-1876.

We performed whole-lake manipulations of fish populations to test the hypothesis that higher trophic levels regulate zooplankton and phytoplanton community structure, biomass, and primary productivity. The study involved three lakes and spanned 2 years. Results demonstrated hierarchical control of primary production by abiotic factors and a trophic cascade involving fish predation.

In Paul Lake, the reference lake, productivity varied from year to year, illustrating the effects of climatic factors and the natural dynamics of unmanipulated food web interactions. In Tuesday Lake, piscivore (bass) addition and planktivore (minnow) reduction caused an increase in zooplankton biomass, a compositional shift from a copepod/rotifer assemblage to a cladoceran assemblage, a reduction in algal biomass, and a continuous reduction in primary productivity. In Peter Lake, piscivore (bass) reduction and planktivore (minnow) addition decreased zooplanktivory, because potential planktivores remained in littoral refugia to escape from remaining piscivores. Both zooplankton biomass and the dominance of large cladocerans increased. Algal biomass and primary production increased because of increased concentrations of gelatinous colonial algae.

Food web effects and abiotic factors were equally potent regulators of primary production in these experiments. Some of the unexplained variance in primary productivity of the world's lakes may be attributed to variability in fish populations and its effects on lower trophic levels.

CARTER, B. T. 1968. Farm pond fish stocking procedures. Farm Pond Harvest 2(3) : 4-6.

CASSELMAN, J. M. and D. A. BROWN. 2000. Quantitative fish community changes after the establishment of exotic species: Assessing the impact of bass introductions on diversity, abundance and biomass. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

Species invasions threaten biodiversity and productivity of fish communities. Twenty-year studies of oligotrophic lake trout lakes in Ontario's Haliburton Highlands provided quantitative data on the impact of bait-bucket introductions of bass. Electrofishing provided numbers and biomass for littoral-zone fish communities in six lakes where lake trout were the dominant predator (rock bass and smallmouth bass absent in two, established in two, and became established in two, appearing at the same time in Macdonald and a decade apart in Clean). Species diversity, which in some lakes was doubled because of other, similar introductions (5-8, native cyprinids, to 12-14, yellow perch and exotic cyprinids), was reduced slightly by smallmouth bass (8-10) but halved by rock bass (7-8). After smallmouth bass became established, fish numbers (approximately 60fl100m^{-2}) were halved, but after rock bass became established, fish numbers decreased by one order of magnitude and lake trout prey by another. Overall fish biomass (approximately 100gfl100m^{-2}) didn't change significantly after smallmouth and rock bass became established, but prey biomass decreased by an order of magnitude after the latter. Once established, rock bass permanently dominate inshore communities, substantially decreasing lake trout prey fish diversity, abundance, and biomass (by 95%) and dramatically reducing lake trout growth and production.

CASTRO, G. A. 1963. Study of survival of stocked channel catfish and other species: Meristic variations of wild and laboratory-raised smallmouth bass (*Micropterus dolomieui*). Arkansas Game and Fish Commission. Little Rock, Arkansas. 97 p.

CATT, J. 1949. Smallmouthed black bass in the waters of New Brunswick and Nova Scotia. Canadian Fish Culturist 4 : 15-18.

Although the smallmouth bass (*Micropterus dolomieu*) is not native to the Maritime provinces, after introduction it has been established in some New Brunswick localities for many years. Its range has recently been extended to certain waters in Nova Scotia.

The smallmouth bass first appeared in the Chiputinicook lakes in New Brunswick approximately eighty years ago and twenty years later in the Kennebacasis River and Spruce Lake. Between 1905 and 1948 there were numerous plantings of small numbers (always less than fifty) of adult smallmouth bass from one lake to the next.

The unauthorized entry of smallmouth bass into Chiputinicook waters from the United States caused a rapid decrease in the numbers of speckled trout, whitefish and to a certain extent sebago salmon (*S. salar sebago*). In contrast, the trout fishery of Kennebecasis has not been greatly affected by the introduction of the smallmouth. Because of the concern over possible detrimental effects to native species more recent plantings have been made with caution, typically into waters which are unfavourable to indigenous species or areas where there is no possibility of migration.

CHEATUM, E., P. FONTAINE and M. LONGNECKER. 1943. Fish culture in north-central and northeast Texas. Field and Laboratory May 1943(2). 79 p.

CHEW, R. L. 1975. The Florida largemouth bass. p. 450-458 *In* R. H. Stroud and H. Clepper [eds.]. Black Bass Biology and Management. Sport Fishing Institute. Washington, D. C.

The Florida largemouth bass differs from the northern largemouth bass in a number of important respects. Identifying characteristics, such as lateral line scale counts and unique isozymes, can be used as tools in research. Differences in growth and utilization of the aquatic environment will be important in the management of the resources and in providing fishermen benefits. The Florida genotype can easily be introduced into existing populations of northern bass. There are also indications that increased numbers of bass will result from such stockings. Immediate research in several vital areas is necessary to eliminate the possibility of detrimental results of such introductions.

CHILDERS, W. S. 1975. Bass genetics as applied to culture and management. p. 362-272 *In* R. H. Stroud and H. Clepper [eds.]. Black Bass Biology and Management. Sport Fishing Institute. Washington, D. C.

Complex evolutionary processes, operating over millions of years, have resulted in populations of bass (*Micropterus*) that are genetically different from one another. Although interspecies hybrids have occurred under laboratory conditions, they rarely occur in nature. In contrast, two subspecies of a given species will almost always freely interbreed with each other and produce fertile offspring if given the opportunity, and their existence depends to a large extent on geographic isolation.

The Florida largemouth bass is not tolerant of prolonged low water temperatures and consequently possesses some genes that are maladaptive for its existence in northern waters. Maladaptive genes once introduced usually take hundreds or thousands of years to be eliminated. There are thousands of genetic differences between the northern and the Florida largemouth bass. The effects of introductions of the Florida largemouth bass into northern largemouth populations are not clear. I strongly recommend that the Florida largemouth bass not be introduced into northern waters, the northern states prohibit such introductions by law, and that such laws be enforced. It is also recommended that the stocking movement of one major geographic area to another be halted to stop the introgression of genes.

CHILDERS, W. F. and G. W. BENNETT. 1967$_a$. Hook-and-line yield of largemouth bass and redear x green sunfish hybrids in a one-acre pond. Progressive Fish Culturist 29 : 27-35.

A primary objective of managing freshwater fish in ponds has been to increase the number of desirable-size fish taken by anglers. Early on, it was discovered that hybrid sunfish are very vulnerable to fishermen's bait. Redear x green sunfish hybrids were planted with various species of fish to determine which combination would give the most favorable yield.

On June 22, 1959, North Pond was stocked with known numbers of F_1 sunfish hybrids and following their growth they were then moved into the east section of the pond on October 5. Two-hundred and fifty bass fry were added the next year along with 140 fingerlings and larger bass, which were scattered throughout North Pond. The pond was also treated with inorganic fertilizer. The catch of bass was considered high for all years after 1960 (when they were planted) and their poundage grew from 46.5 pounds per acre in 1961 to 105.3 in 1962. However, the bass were small in size (likely because of sunfish hybrid overpopulation). Later studies did show that a few bass escaped capture to eventually grow to a large size. The lack of bass over 2 pounds, six years after planting suggests that the bass were being fished efficiently enough that the population of sunfish was not negatively effected. Spawning by bass did occur as the creel census conducted at the end of six years revealed 311 bass of intermediate sizes, thought to be yearlings and two-year-olds. It is speculated that bass catches were high because the hybrids themselves were highly aggressive, causing the need for the largemouth bass to become more voracious in order to catch their prey.

CHILDERS, W. F. and G. W. BENNETT. 1967$_b$. Experimental vegetation control by largemouth bass-tilapia combinations. Journal of Wildlife Management 31 : 401-407.

CHRISTENSON, L. M., A. M. FORBES and J. J. KEMPINGER. 1982. Improved angling quality following chemical treatment of Nebish Lake and re-introduction of smallmouth bass and yellow perch. Research Report 115. Wisconsin Department of Natural Resources. Madison, Wisconsin. 16 p.

CHRISTIE, W. J., J. M. FRASER and S. J. NEPSZY. 1972. Effects of species introductions on salmonid communities in oligotrophic lakes. Journal of the Fisheries Research Board of Canada 29 : 969-973.

Adequate documentation was often wanting for interpretation of conditions surrounding the success or failure of an exotic. There was also known differences in species composition and other circumstances which made comparisons between SCOL lakes difficult.

Successful colonization appeared possible where a sufficiently plastic new species found a niche either temporarily or permanently void. The lack of normal ecological constraints favored the explosion of a colonist, and examples were found which indicated both physiological and behavioral adaptation to permit establishment. The data suggested predation may be important in suppressing invaders. The higher diversity of littoral fish communities provided greater resistance to colonists. The role of exploitation in the fate of any colonist seemed chiefly in its effect on diversity and on stock oscillations. Eutrophication favored the success of colonists through continued destabilization of communities. It was suggested that management should proceed towards greater diversity to minimize the chances of outbreaks of pest fishes.

The introduction of "edge" species (those which inhabit the littoral or tributary waters of an oligotrophic lake) has proved successful in the cases of the largemouth and smallmouth bass. In many cases these fish are able to colonize new waters because there is an open niche. In the case of the smallmouth bass they exploit the crayfish populations more than any other species and are therefore able to easily establish themselves.

CICHRA, C. E., W. H. NEILL and R. L. NOBLE. 1981. Differential resistance of northern and Florida largemouth bass to cold shock. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 34 : 19-24.

Texas stocks of northern and Florida largemouth bass (*Micropterus salmoides salmoides* and *M. s. floridanus*) were compared for resistance to cold shock. The 45 advanced fingerlings of each subspecies had nearly identical rearing histories and were acclimated to a common temperature near 21°C. Laboratory tests were conducted at constant temperatures ranging from 5.3° to 13.5°C. Over all tests, more than twice as many Florida bass as northern bass died during the 7 days of observation. We estimated that the 96-h median tolerance limit was about 6°C for northern bass and about 8.5°C for Florida bass. These findings are consistent with the hypothesis that Florida bass stocked outside their original range may suffer higher overwinter mortality, owing to lesser cold tolerance, than native northern bass.

CLADY, M. D. 1980. Results of stocking young largemouth and spotted bass in several ratios in an Oklahoma pond. Proceedings of the Oklahoma Academy of Science 60 : 18-25.

CLARK, M. 1952. Kentucky's farm fish pond program. Journal of Wildlife Management 16(3) : 262-266.

Success in establishing good fishing in unstocked ponds is directly related to methods, rates, species and sizes stocked. During the last seven years many species, various rates, and different size fish have been planted in ponds in Kentucky.

Only the bass-bluegill combination has been successful in Kentucky ponds, i.e., excellent fishing is provided from one year to the next. The stocking rate which was found to give the best results was 30 adult bluegills and 100 bass fry, where bluegills are planted from October through June and the bass fry planted in May. The addition of another species, the white crappie (*Pomoxis annularis* Rafinesque), with adult bluegills and bass fry resulted in a stunted crappie population by the fourth year.

Bluegills have been stocked as fingerlings in 492 fertilized Kentucky ponds using the combination of 1,000 bluegills and 100 bass fry. This method was not shown to be beneficial in Kentucky as by the fourth year the bluegill population was stunted and the bass were in poor condition. It appears that in Kentucky the "traditional" stocking ratio of 1,000 bluegills and 100 bass fingerlings is inferior to that of 30 adult bluegills and 100 bass fry.

CLUGSTON, J. P. 1964. Growth of the Florida largemouth bass (*Micropterus salmoides floridanus*) and the northern largemouth bass (*M. s. salmoides*) in subtropical Florida. Transactions of the American Fisheries Society 93(2) : 146-154.

Three ponds near Fort Lauderdale, Florida were stocked with Florida largemouth bass fingerlings in April 1960. In July 1960, two ponds were stocked with northern largemouth bass fingerlings imported from Iowa. Samples of the bass were collected every month from each pond. The objectives of the study were: to investigate the seasonal pattern of growth of the largemouth bass, to determine possible differences in growth rates related only to the advent of sexual maturity, and to determine whether or not these subspecies would show differences in growth rate when grown under similar conditions in Florida.

Temperature conditions in south Florida appear to be suitable for growth of the largemouth bass the year around. Both subspecies grew very fast in the study ponds. The northern form grew more rapidly than the southern bass during the early life history, but temperature differences could account for this difference in growth. The northern bass did not become mature during the experiment and the southern form matured at about 9 months of age. The length-weight relationship of the bass populations differed although there is no evidence that these are related to the subspecies. All of the bass populations exhibited high condition factors for most of the year and, in general, the populations that consistently exhibited the highest condition factors grew faster than those with lower condition factors.

COBLE, D. W. 1971. Effects of fin clipping and other factors on survival and growth of smallmouth bass. Transactions of the American Fisheries Society 100 : 460-473.

Fin-clipped and control young-of-the-year smallmouth bass (*Micropterus dolomieui*) were stocked in eight ponds and recovered a year later. A fin clip reduced survival; percentage recovery of fin-clipped bass was about one-half to one-third that of control fish. No effect of fin clipping on growth was evident. Growth was inversely related to bass population density. When the effect of density on growth was removed, growth appeared to be curvilinearly related to minnow standing crop. Growth appeared to be food dependent at the lower food levels and independent at higher levels.

COLGAN, P. W., J. A. BROWN and S. D. ORSATTI. 1986. Role of diet and experience in the development of feeding behavior in largemouth bass (*Micropterus salmoides*). Journal of Fish Biology 28(2) : 161-170.

Two groups of largemouth bass (*Micropterus salmoides*) were reared in the laboratory. One group was reared on an artificial, passive diet (frozen brine shrimp) whereas the second was reared on a natural, active diet (cultured zooplankton). Observations on the development of feeding behaviour indicated that the motor patterns and duration (number of weeks in the behavioural repertoire) of the feeding acts did not differ between fry reared on the two diets. While feeding on their respective diets, natural-diet fry performed significantly more orientations and bites, the two major early feeding acts, than did the artificial-diet fry. When tested with live fish prey, fish reared on the natural diet performed fewer orientations and strikes and captured more prey per fry than did than artificial-diet fry. Natural-diet fry had a significantly better net efficiency (captures minus strikes minus orientation) than did artificial-diet fry. Diet, experience, and length (TL) of fry affected their predator efficiency significantly. We argue that providing hatchery-reared bass fry with an opportunity to prey on live forage fish once or twice before their release would enhance their survival and eventual recruitment into natural populations.

COLLINS, C. and A. J. MITCHELL. 1996. Fish stocking in recreational ponds. Aquaculture Magazine 22(6) : 74-75.

Fishing in ponds is a heritage in the United States. Ponds are a very valuable fishing resource and if stocked and managed properly, can provide endless hours of fishing recreation. Improper stocking of fish can ruin a pond's value as a resource and limit the potential for fishing pleasure. This article discusses many stocking issues including the types and size of fish to stock, when to stock, the numbers of fish to stock, availability of stockers, and supplemental stocking.

Observations have shown that in ponds of less than one acre it is extremely difficult to maintain a balance between the prey and the predators. With bluegills and largemouth bass, bluegills tend to become over-populated as the bass are overfished, thus resulting in large, stunted bluegill and weak bass populations. It is recommended that fingerling bass and bream be stocked together. If supplementary stocking of bass populations is necessary, only large (6- to 8-inch) fingerlings should be used. In an already stocked pond, without predator fish, 2- to 3-inch fingerlings can be stocked.

All bream should be stocked in the fall and the bass, the following spring. The reasoning is that the forage fish will have time to escape predation through growth and in turn spawn to provide food for the bass. As a general rule, twice as many largemouth bass should be stocked into fertilized new or renovated ponds as unfertilized.

COOPER, G. P. 1948. Fish stocking policies in Michigan. Transactions of the Annual North American Wildlife Conference 13 : 187-193.

Major emphasis of fish plantings have been on the trouts, the basses and bluegills, perch and walleye. The total number of bass fry and fingerlings planted in Michigan Island waters by State hatcheries between 1937 and 1946 was 8,229 fish. Currently, Michigan's policy is the near total termination of stocking warm water species. Over the years 1936 to 1945 an annual average of 2.4 largemouth bass fingerlings per acre were distributed to 687 lakes with a mean area of 381 acres. The number of smallmouth bass planted is even less, 1.9 fingerlings per acre in 308 lakes of an average 492 acres. Evidence demonstrates that the number of warm water fish stocked is so minute in comparison to the actual number of fish present in a lake that stocking is having no effect on the population numbers. Many lakes have maintained outstanding fishing without plantings.

COPELAND, J. R. and R. L. NOBLE. 1994. Movements of young-of-year and yearling largemouth bass and their implications for supplemental stocking. North American Journal of Fisheries Management 14(1) : 119-124.

Young-of-the-year (age-0) largemouth bass (*Micropterus salmoides*) from the Little Beaver Creek embayment of B. Everett Jordan Lake, North Carolina, were individually tagged with magnetic binary coded wire tags in 1989 and 1990. Fish were recaptured during electrofishing and seine sampling in the year of tagging and the following year. In 1989, 529 age-0 largemouth bass were tagged, of which 40 were recaptured. Of these, only 2 of 31 age-0 and 2 of 9 yearling fish had moved out of their tagging coves. In 1990, 1,090 age-0 largemouth bass were tagged, of which 47 were recaptured. Of 15 recaptured largemouth bass that had been tagged in coves, only 2 age-0 fish had moved from their tagging coves. Of 32 recaptured largemouth bass that had been tagged outside coves, only 2 age-0 and 1 yearling fish had moved into cove areas. No tagged age-0 or yearling largemouth bass were recaptured outside the embayment. Because most fish seem to stay near their tagging site, localized supplemental stocking of fingerlings may benefit largemouth bass populations in basin, bay or cove areas of large complex reservoirs.

CRANCE, J. H. and L. G. McBAY. 1966. Results of tests with channel catfish in Alabama ponds. Progressive Fish Culturist 28(4) : 193-200.

In 122 privately owned ponds, channel catfish were stocked at different rates in combination with largemouth bass, bluegills, and redear sunfish, and with largemouth bass alone, to obtain information about the feasibility of a channel catfish stocking program in Alabama.

Pond-owners' cooperation was poor, specifically in supplying catch data and following recommended feeding programs. Fifty-five ponds could not be evaluated to any extent, and many other ponds had only enough data for partial evaluation.

In ponds first stocked with 50, 100 or 150 channel catfish, 1,000 bream, and 100 largemouth bass per acre, seine analysis revealed no appreciable effect on balance in the first 3 years. However, the average weight of bream in the first year of fishing was about 30% less in ponds stocked with 150 channel catfish per acre than in ponds with 50 per acre. Work is needed to determine how initial stocking of 50 and 100 channel catfish per acre with largemouth bass and bream affects total catch.

Average catches of 55.7 pounds and 33.0 pounds of channel catfish per acre were reported during the first and second years of fishing, respectively, in ponds stocked with 500 channel catfish and 100 largemouth bass per acre, and fertilized.

Ponds stocked with 2,000 channel catfish and 100 largemouth bass per acre and fed, yielded an average of 672 pounds of channel catfish in the first year of fishing and an average of 413 per acre in the second. Ponds stocked with 3,000 channel catfish and 100 largemouth bass per acre and fed, yielded averages of 533 and 524 pounds of channel catfish per acre in the first and second years, respectively.

These tests showed that ponds 0.1 to 0.25 acre in size can be used for channel catfish production if stocked at a rate of 2,000 or 3,000 per acre and fed properly.

The rate and frequency of restocking channel catfish in ponds in order to sustain a desirable fishery for this species were not determined, but must be considered in evaluating a channel catfish stocking program by State or Federal Agencies.

CRAWFORD, S., W. F. PORAK and D. J. RENFRO. 1995. Largemouth bass investigations: Increase recruitment and population size of largemouth bass by stocking. Phase II Management of largemouth bass populations. Florida Game and Freshwater Fish Commission. Tallahassee, Florida. 76 p.

CRAWFORD, S. and A. M. WICKER. 1987. Recruitment of stocked largemouth bass fingerlings into a central Florida fishery. Florida Science 50(4) : 211-215.

CROSS, F. B. 1971. Cooperative fisheries investigations: Investigations on combinations of largemouth bass and two species of catfishes. Dingell-Johnson Project KAN F-12-R-7, Job No. 7. Kansas Forestry, Fish and Game Commission. Emporia, Kansas. 24 p.

Eight ponds were stocked in different combinations of the catfish and bass. Growth rates for each pond was determined and is discussed. Feeding trials were conducted to determine the size and number of brown bullheads that bass of various sizes can consume.

CROSSMAN, E. J. Undated. The smallmouth bass and largemouth bass. p. 21-25 *In* Quetico Fishes. Royal Ontario Museum Quetico Foundation. Toronto, Ontario.

It is suspected that the presence of smallmouth bass in Quetico Park is due to introductions made by the Minnesota Department of Natural Resources around 1941 into Basswood Lake. Further introductions were made in 1942 and 1946, with none having been made since. Although no record exists of introductions being made in the Canadian waters of Quetico, other sources have stated that introductions near Kenora were responsible for the majority of the smallmouth near border waters.

The largemouth bass was introduced much later, in 1945, to the Border Waters of Quetico. Unfortunately, in years past many misidentifications were made and it is possible that the smallmouth and largemouth basses were confused on many occasions.

CROWELL, E. F. 1980$_a$. Annual performance report for Statewide Fisheries Research Project, part II of III, Subsection II: Black bass research. Study II: Smallmouth bass stocking evaluation. Job II-1 Fish population survey. Dingell-Johnson Project

KY F-40, Segment 2. State of Kentucky Department of Fish and Wildlife Resources. Frankfort, Kentucky. 4 p.

Smallmouth bass, 1.25 to 2.5 inches long, have been stocked in Herrington Lake since 1978 at a rate of about 40 fish per acre in an attempt to re-establish the species. As part of the evaluation of this stocking effort, two cove-rotenone studies totaling 3.72 acres were conducted at Herrington Lake during July and September 1979 that yielded 28,242 fish per acre (f/a) and 653 pounds per acre (lb/a). The forage species, primarily gizzard and threadfin shads, made up the bulk of the population. The smallmouth bass population was represented by 4 specimens (1.1 f/a and 0.20 lb/a). These fish were 7 and 8 inches long and were from the initial stocking in June 1978. The Y/C ratio was 1.88 indicating a healthy, well-balanced fish population.

CROWELL, E. F. 1980$_b$. Annual performance report for Statewide Fisheries Research Project, part II of III, Subsection II: Black bass research. Study II: Smallmouth bass stocking evaluation. Job II-3 Age and growth determinations. Dingell-Johnson Project KY F-40, Segment 2. State of Kentucky Department of Fish and Wildlife Resources. Frankfort, Kentucky. 1 p.

Project planning called for the determination of age-growth data from smallmouth bass collected during the performance of Job II-1 at Herrington Lake; however, the small number of specimens collected negated these efforts. Four of the five fish collected within cove-rotenone study areas were 7 or 8 inch fish that were determined to be age I+; a 5-inch specimen collected outside one of the study areas during cove-rotenone sampling was an age 0+ fish.

CRUTCHFIELD Jr., J. U., and W. J. WARREN-HICKS. 1985. Comparison of population estimates on a known largemouth bass population. Proceedings of the Annual Meeting of the Southeastern Association of Fish and Wildlife Agencies 39 : 261-268.

Population estimates were calculated for a known, previously stocked, young-of-the-year (YOY) largemouth bass (*Micropterus salmoides*) population in a Piedmont North Carolina pond. Bass were collected by electrofishing for 6 consecutive nights. Estimates were derived using capture-recapture (Chapman, Chapman modified Peterson, Schnabel, and Schumacher-Eschmeyer) and removal (Leslie and DeLury) methods. Accuracy and bias of population estimates for each method were assessed from a statistical framework. All methods gave negatively biased estimates. Schumacher-Eschmeyer and DeLury exponential catchability models gave minimally-based, accurate estimates within 12 to 17% of the true population. Independent Chapman estimates also gave acceptable results (known population within 95% confidence limits) when at least 56% of the known population was marked and the number of sampling occasions > 4.

DADZIE, S. and P. A. ALOO. 1990. Reproduction of the North American black bass (*Micropterus salmoides*) in an equatorial lake, Lake Naivasha, Kenya. Aquaculture and Fisheries Management 21(4) : 449-458.

The blackbass (*Micropterus salmoides*) was introduced to Lake Naivasha, from North America in 1929 (Aloo 1988). In contrast to its North American relatives, the Lake Naivasha blackbass, has a prolonged spawning of 8 months between June and January, peaking in August to November. This season is characterized by the presence of high numbers of mature fish with the highest gonadosomatic index (GSI). Analysis of GSI variations in different length-classes reveals that maximum reproduction occurs in the 30-34.9-cm length-class in males and 40-44.9-cm in females. Analysis of the GSI values in the different sampling stations identifies two stations as the breeding areas of *M. salmoides* in the lake.

The positive correlation between the GSI and the stomach fullness index suggests that the species probably feeds all year round, including the spawning season. Fifty percent of males and females are mature at 25-29.9-cm and 30-34.9-cm length-classes, respectively. The fecundity of fish of 28.4 cm (371 g) to 33 cm (550 g) ranged from 1300 to 3524 with a mean of 2203 eggs. Fecundity had no relationship with body length, but increased linearly with body weight.

DAHLBERG, M. D. and D. C. SCOTT. 1971. Introductions of freshwater fishes in Georgia. Bulletin of the Georgia Academy of Science 29(4) : 245-252.

Fishes introduced into Georgia and dispersed within the state have considerably enhanced sport fishing and the commercial distribution for catfishes. The sources, purpose, success, results and distribution of these introductions is evaluated as far as is known.

The smallmouth bass was originally only present in the Tennessee drainage, yet has been widely stocked throughout streams in the Appalachian foot hills. In this area it has been successful in filling the ecological and temperature gap between the largemouth bass and numerous salmonid species. Its current distribution includes the Coosa drainage and although it has been stocked into both the Apalachicola and Savannah drainages, its status is unknown. It is currently used for supplemental stockings in the Tennessee drainage.

DAMES, H. R., R. A. KRAUSE and R. A. DeMAURO. 1996. Panhandle sport fisheries investigations: Largemouth bass stocking evaluation. Dingell-Johnson Project FL F-36-R-15. Florida Game and Freshwater Fish Commission. Tallahassee, Florida. 28 p.

The Shoal River and Holmes Creek were chosen to evaluate stocking of advanced fingerling largemouth bass as a method of enhancing stream fisheries.

DAVIES, W. D. 1973. Florida largemouth bass in Alabama waters as a management tool. Annual Report, Fisheries and Allied Aquacultures Department, Auburn University Agricultural Experiment Station. Volume 14. Auburn, Alabama.

DAVIES, W. D. 1974. Managing small impoundments and community lakes. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 27 : 347-355.

Farm ponds and community lakes attract a large number of fishermen. Present management practices for largemouth bass-bluegill ponds are adequate, but intense study of optimum rates of exploitation and fertilization should provide for more efficient techniques. Strategy and tactics for the future should consider energy flow patterns in fish communities. Study of how these patterns are altered and what are the losses when fishing or other stresses are applied, should provide new management concepts.

The objective of pond stocking is to produce a population which can be fished annually. A recommended stocking rate for the bass-bluegill combination is 100 bass fingerlings and 1,000 to 1,500 bluegill fingerlings per acre. Swingle (1966) discovered that the addition of 1,000 fathead minnows with the bluegill fingerlings in the fall would result in a higher bass production and survival rate. If the overcrowding of bass is desired, to limit the number of bluegills it is suggested that adult bass be stocked at a rate of 2-3 per acre. If there is risk of insufficient bass forage survival (a typical occurrence when using fathead minnows), then the supplemental feeding of the forage species may be of use. In addition the alteration of the bass stocking rate to fit the projected survival of the forage should create a satisfactory bass fishery. The use of bass in corrective stocking has not demonstrated its usefulness.

DAVISON, V. E. 1955. Managing farm fishponds for bass and bluegills. United States Department of Agriculture, Farmers' Bulletin No. 2094 : 1-18.

DAWSON, J. B. 1960. The smallmouth black bass. Special Fish and Wildlife Bulletin 2. Ontario Department of Lands and Forests. Kemptville, Ontario.

This report deals with the life history, current research and management of the smallmouth bass as they apply to Ontario conditions. The smallmouth bass was originally found only in the St. Lawrence River and Great Lakes drainage system of Ontario and Québec. In the United States the range included the Upper Mississippi to the Tennessee River drainage in Alabama, reaching eastern Oklahoma and to North Carolina.

During the last ten years in Ontario smallmouth bass plantings have dropped dramatically. In 1948, 1,961,000 bass of all sizes were distributed compared to only 160,300 in 1959. Through a questionnaire it was discovered that most districts are planting relatively few bass. In the southern region bass are being planted only where winterkills have occurred, where water elevations have affected natural reproduction or for introductory purposes. In the northern districts, there is little if any bass planting. The stocking that does occur primarily involves the transferring of bass for introductory purposes. A survey of a few states indicated that Vermont and Maine were not stocking bass and that New York is stocking an unknown amount. It has been found through tagging experiments that that planting in the Great Lakes and the St. Lawrence River are likely futile endeavours because these areas are large open systems.

DAWSON, J. B. 1999. Railway bass. Ontario Out of Doors June(1999) : 20-25.

In the 1920s and '30s, the Ontario Department of Game and Fisheries (ODGF) cultured large numbers of fingerling bass at Normandale and Mount Pleasant hatcheries, among others, and later at Westport in eastern Ontario. Adult bass were also netted for transport to new waters. The Department had its own railway car for fish transport and it planted bass from one side of the province to the other, seemingly with little thought as to the suitability of habitat. Since then, illegal non-government bass introductions and natural dispersal have blurred the initial railway introduction trail. The Rainy River basin was planted with "railroad" smallmouth as early as 1903 according to the ODGF's annual report of that year. The species was non-native to that portion of the province. Largemouth might have been stocked accidentally along with smallmouth. Both species were cultured in hatchery ponds in southern Ontario and often were transported together in railway cars.

In early days, ice was used to cool and increase oxygen-holding capacity during transport. Arranging for ice on route and for assistance in planting fish in countryside remote from the railway was difficult. It was easier to stop at a trestle over creeks and rivers and plant fish directly from the railway car. Plantings farther afield employed trucks, cars, horse-drawn vehicles and backpacks.

The shotgun approach to bass introductions had some successes, but it also spoiled may speckled trout waters and produced large numbers of stunted bass in others. The government planted bass over established populations into the 1950s but research indicated this was wasteful and unnecessary so it was discontinued.

DeFOREST, S. 1990. Clear (Gravel) Lake smallmouth bass assessment. File Report. Ontario Ministry of Natural Resources. Kapuskasing, Ontario. 5 p.

Smallmouth bass were introduced to Clear (Gravel) Lake in 1983 with 112 adults being stocked followed by 87 adults in 1984. On August 3, 1990, a smallmouth bass assessment was done to verify the success of past introductions. Two 400 foot gill nets were set in the lake for durations of two hours and one and one-half hours. Shoreline seines were done in sandy areas to capture young-of-the-year bass. The first gill net caught nine smallmouth bass. The second gill net had one walleye and twelve white suckers. Approximately 50 smallmouth bass fry were caught in each of the four seine nets.

The nine smallmouth bass netted in Clear Lake were two or three year olds. The bass fry netted in the seine and the adults show natural reproduction and recruitment and indicate that the 1983 and 1984 introductions were successful. All fish appeared to be in excellent condition. There is every indication that Clear Lake now has a self-sustaining population of smallmouth bass.

DEGANI, J. G. 1950. Results of stocking experiments in eight experimental farm ponds in Boone County, Missouri. Dingell-Johnson Project MO F-1-R-16, Work Plan No. 4, Job No. 7. Missouri Department of Conservation. Jefferson City, Missouri. 13 p.

DEGANI, J. G. and M. HAMILTON. 1969. Evaluation of two stocking methods for Missouri farm ponds. Dingell-Johnson Series No. 7. Missouri Department of Conservation. Jefferson City, Missouri. 17 p.

DENMEAD, T. 1950. Black bass in Maryland. Progressive Fish Culturist 12(1) : 35-37.

It is believed by many (as is apparent in recent publications) that the black bass was introduced into Maryland around 1853 or 1854 by William Shriver, from the Ohio River water system. The smallmouth bass were then stocked into the Potomac River for cultivation. Around 1850, both small and largemouth bass were referred to as *Micropterus salmoides*, thus causing confusion as to which species was actually introduced. The smallmouths proliferated. It is suspected that sometime in the late 1800s largemouth bass were introduced in the Potomac River, yet by all indications they do not appear to be as successful in their colonization of the watershed as the smallmouths.

DEUTSCH, W. G., E. C. WEBBER, D. R. BAYNE and C. W. REED. 1992. Effects of largemouth bass stocking rate on fish populations in aquatic mesocosms used for pesticide research. Environmental Toxicology and Chemistry 11(1) : 5-10.

DEYNE, G. and L. TOUGH. 1995. Smallmouth bass (*Micropterus dolomieu*) nesting survey Kawagama Lake, 1995. Ontario Ministry of Natural Resources. Parry Sound, Ontario. 6 p. + appendices.

Smallmouth bass were introduced to Kawagama Lake prior to 1940 and have survived to provide a fishery, although they are at the northern tip of their range. Upon introduction to coldwater lakes, smallmouth bass have a tendency to outcompete (for food and space) both native and stocked brook trout. Concerns over the early opening of the bass season and its impact on spawning prompted a nest guarding study. This study was conducted on June 24, 1995. It was found that any negative impact caused by angling smallmouth bass while still in the process of spawning was minimal. There was no information to indicate that the bass were being over harvested.

DICKSON, F. J. Undated. Stocking. ch. 5 *In* Georgia Fish Pond Management. Georgia Game and Fish Commission. Atlanta, Georgia. 89 p.

Prior to stocking a pond there are many aspects to consider and many guidelines to follow. Most importantly, the number of fish entering a system should literally be counted and only hatchery-reared fish should be used to prevent the entry of a disease or parasite.

Largemouth bass should automatically be placed in any pond in Georgia as their predatory presence will keep the bream population under control. If the pond is managed properly, one year after stocking the bass should weigh around one pound each. Bluegills are considered the "beef cow" of the bream fish and should be stocked as food for the bass. It has been demonstrated that ponds which are stocked solely with bass and bluegills yield better results than those stocked with three or more species. This species combination is also the simplest to manage.

Depending upon whether or not a pond is to be fertilized, the ratios of bluegill and largemouth bass per acre must be adjusted. In a fertilized pond 1,000 bluegill fingerlings should be stocked in the fall or winter along with either 100 bass fingerlings at the same time or 100 fry the following spring. An alternative to bluegills only is a combination of bluegills and shellcrackers (850 and 150, respectively in the fall or winter) followed by 100 bass fingerlings or fry, during the same periods as was previously mentioned. In an unfertilized pond only 400 bluegills should be planted, along with 30 bass fingerlings. Another option is to substitute 60 of the bluegills for 60 shellcrackers while keeping all of the planting seasons identical in the four cases. It is not advisable to stock with more than one-fifth of the bream consisting of shellcrackers as they are not as hardy as the bluegills and it is likely that the bass will have eliminated them by the third year after the initial stocking.

DILLARD, J. G. 1971. Evaluation of two stocking methods for Missouri farm ponds. p. 205-211 *In* R. J. Muncy and R. V. Bulkley [eds.]. Proceedings of the North Central Warmwater Fish Culture Management Workshop. Iowa Cooperative Fisheries Unit, January 21-22, 1971, Ames, Iowa.

DILLARD, J. G. and M. HAMILTON. 1969. Evaluation of two stocking methods for Missouri farm ponds. Dingell-Johnson Project MO F-1-R-18/SP7. Missouri Conservation Commission. Jefferson City, Missouri. 18 p.

DILLARD, J. G. and G. D. NOVINGER. 1975. Stocking largemouth bass in small impoundments. p. 459-474 *In* H. Clepper [ed.]. Black Bass Biology and Management. Sport Fishing Institute. Washington, D. C.

Largemouth bass have been considered for stocking ponds since the late 1800s and early 1900s. They have been tested in small impoundments alone and in combination with a variety of other fish species but most of the studies could be categorized into bass alone, bass-"minnows", or bass-sunfish. These experiments were conducted to determine the best or ideal combination of fishes, the numbers to stock, the ratios, the time of year and other factors. Disagreement between investigators and fisheries managers in various regions of the United States began as soon as the first results were obtained. These arguments plus an attempt by some fish stocking agencies to standardize the numbers and species of fishes offered to pond owners or for stocking public impoundments hindered the development of flexible bass stocking strategies and policies.

Much information has been gained about stocking and managing small impoundments for largemouth bass fishing. Many of the factors to be considered in making recommendations to pond owners or for public fishing lakes are now recognized. The most obvious task remaining is to use this information in a more systematic fashion to increase the success of bass stocking attempts and minimize the failures. The main factors that should be considered in redesigning bass stocking strategies and policies are geographical region of the pond or lake, pond owner or anglers species preference, and the specific characteristics of the pond or lake to be stocked. Stocking recommendations based on these factors could be many and varied and at first glance might seem difficult to implement. On the other hand, the pond owner may be able to aid in implementing new stocking strategies. For instance, pond owners seeking recommended species unavailable from state or federal hatcheries could buy them from other sources. Theoretically, such a pond owner would be motivated to properly care for and manage his pond and thus have a greater probability of creating and maintaining good fishing.

Perhaps the goal of managing each pond on an individual basis is idealistic but greater success could be attained by pursuing such a goal. The alternative of one species combination for all ponds has not been totally successful either. Too many fish have been stocked the wrong way in the wrong waters and for people who did not want them in the first place. Surely, the cost-benefit ratio of establishing largemouth bass in small impoundments could be improved by using a different approach to this important fisheries management challenge and opportunity.

DOAN, K. H. 1940. Studies of the smallmouth bass. Journal of Wildlife Management 4 : 241-266.

There are very few positive outcomes when smallmouth bass are introduced into a lake. If water temperatures are low feeding and spawning will be inhibited, resulting in no or little survival. In small lakes with rocky or boggy bottoms and no lasting food sources the smallmouth bass will appear to thrive for a few years, even reproduce. Yet, once the food stock is depleted the population will become small and stunted and unsuitable for fishing. Lake Opeongo, a large, deep, northern lake, has bass which are currently experiencing high levels of growth yet it is suspected that the fishery will not last, as food sources run out. The introduced smallmouth bass populations of two small, deep, northern lakes (Cache and Meach) have shown poor growth as has that of the shallow Found Lake. Native bass can, however, be maintained in shallow lakes and it is in the best interest of the population if a form of rehabilitation other than supplemental stocking is undertaken.

DUERRE, D. C. 1966. Evaluation of fish rearing areas. Dingell-Johnson Project ND F-2-R-12, Job No. 11, Final Report. North Dakota State Game and Fish Department. Bismarck, North Dakota. 17 p.

DUNHAM, R. A., C. J. TURNER and W. C. REEVES. 1992. Introgression of the Florida largemouth bass genome into native populations in Alabama public lakes. North American Journal of Fisheries Management 12(3) : 494-498.

Many public fishing lakes constructed in Alabama first contained the state's native largemouth bass (*Micropterus salmoides*) which has allozyme frequencies similar to those of the pure northern species (*M. s. salmoides*). Many of these lakes then were supplementally stocked with largemouth bass fingerlings with allozyme frequencies similar to those of the Florida subspecies (*M. s. floridanus*). The supplemental introductions had varying success, and 10 of 11 populations we examined had undergone significant ($P < 0.05$) allele-frequency changes – representing introgression of Florida alleles – at the diagnostic loci sAAT-B*, sIDHP*, and sSOD*. We evaluated several variables for their effects on introgression: number of years (6-18) since initial stockings of Florida largemouth bass, number of stockings (3-11), stocking densities (334-1,430/ha), Secchi disk visibility (18-33 cm), and latitude (31°30'-34°90' N). All variables except latitude affected or were correlated with percent introgression, which ranged from 11 to 69%. Number of stockings was identified by step-wise multiple regression as the most influential variable ($r^2 = 0.77$) on introgression. The best two-variable model ($r^2 = 0.82$), which also incorporated years since initial stocking, was not different from the best one-variable model. Similar experiments previously reported from Texas also identified number of stockings as having the most influence on introgression; however, water clarity was positively correlated with introgression of Florida largemouth bass alleles in the Texas study but negatively correlated in ours.

DYCHE, L. L. 1913. Possibilities of an acre fish pond. Transactions of the American Fisheries Society 43 : 67-75.

In the spring of 1910, a 1.16 acre pond at the Kansas State Fish Hatchery was stocked with 10,000 yearling fish of various species such as black bass, crappie, bluegill, sunfish, common green sunfish, bullhead catfish, a few hickory shad and German carp and 300 goldfish. Most of these fish were planted as a food source for the predatory species. In the fall of 1910, a thousand more fish were stocked including 200 black bass four to six inches long. Fifteen hundred crappie were planted in the spring of 1911, as were 2,000 bullhead catfish, 192 channel catfish and 1,000 miscellaneous fish. In 1912 and 1913 thousands of fish were observed, among them bluegills, bass, sunfish, carp, goldfish, shad and bullheads. In the spring of 1913 most of these fish were then used to stock other ponds at the new hatchery. In total, approximately 16,000 young fish were planted into the ponds and when the pond was drained 27,000 fish of various ages were removed.

DYMOND, J. R. 1931. The small-mouthed black bass and its conservation. Biological and Fish Culture Branch Bulletin No. 2. Ontario Department of Game and Fisheries. Toronto, Ontario. 10 p.

The life history of the smallmouth bass as it pertains to species conservation is discussed. It is noted that for every 10,000 eggs which are viable in the wild, only two of those fish will survive to the adult stage. It is speculated that for this reason failure will almost always result when fry are used for re-stocking purposes, unless exceedingly high numbers of fry can be reared/transferred with some degree of economic feasibility. Failure of fry-stocking projects may not be the result of inferior artificially-raised fish, simply a substandard number of individuals stocked. However, when stocking streams and small bodies of water a few thousand fry may constitute a significant contribution to the bass population.

The Government is currently developing ponds for bass culture in addition to those which already exist at the Mount Pleasant Hatchery. The transfer of bass from one lake to the next is being used as a viable management practice. Lake on the Mountain in Prince Edward County supplied 123,000 fry, from adults who spawned on man-made gravel nests, to be introduced into protective areas in suitable waters in the same and neighboring counties.

DYMOND, J. R. 1935. Preliminary report on fish and fishing in Cache Lake, Algonquin Park. Ontario Fisheries Research Laboratory. Department of Biology, University of Toronto. Toronto, Ontario. 3 p.

Eleven species of fish were found in Cache Lake, the smallmouth black bass included. This species is not native to the lake and was initially introduced in 1899. There are very few minnows in the lake and it is hypothesized that this may be the result of an unbalanced system created by the introduction of the bass. It is predicted that during the re-establishment of this balance the lake trout may be eliminated from the lake.

EBERT, D. J., J. C. BELLEMORE and J. S. FORESTER. 1985. Restoration of warm water lakes and ponds in the national forests in Mississippi and Louisiana. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Management Agencies 39 : 269-276.

The United States Forest Service has been trying to improve the fish population structure of 120 flood control lakes and ponds in the National Forests of Mississippi and Louisiana. Recent efforts have included supplemental stocking, complete eradication of existing populations followed by restocking, and selective species eradication. Since 1978, 36 lakes, 25 ponds and 59 livestock and wildlife watering ponds varying in size from 0.1 to 940.5 ha have undergone fish population alteration. Fifty-three of these lakes and ponds were completely restocked, while 57 have received supplemental stocking. Preferred species combinations in restocking programs have been largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*) and redear sunfish (*L. microlophus*), and channel catfish (*Ictalurus punctatus*) at rates of 20, 200, 20, and 12-45/ha, respectively. Supplementally stocked species have been largemouth bass, spotted bass (*M. punctulatus*), Florida bass (*M. salmoides floridanus*), catfish (*I. Furcatus*), channel catfish, and redfin pickerel (*Esox americanus*). In 84% of improved lakes and ponds, angler success has markedly improved. In supplementally stocked lakes, channel catfish stocked at 12-20/ha have increased angler harvest and angler use days by 28%. Addition of redfin pike at 2/ha has diversified fishing interest in several dysotrophic lakes. Supplemental stocking of blue catfish in small watering ponds is intended to reduce overcrowded sunfish populations. Eradication of gizzard shad (*Dorosoma cepedianum*), golden shiners (*Notemigonus crysoleucas*), and lake chubsuckers (*Erimyzon sucetta*) in 4 lakes has revitalized stunted bluegill and redear sunfish populations.

EDITOR. 1952. Introduction of exotic fishes to the Cape Province. Piscator 6(22) : 57-64.

EDWARDS, G. S. 1977. Evaluation of management alternatives for small desert lakes. Dingell-Johnson AZ Project F-14-R-11, Work Place 5. Arizona Game and Fish Department. Phoenix, Arizona. 4 p.

EDWARDS, R. J. 1979. A report of the Guadalupe bass (*Micropterus treculi*) x smallmouth bass (*M. dolomieui*) hybrids from two localities in the Guadalupe River, Texas. Texas Journal of Science 31 : 231-238.

EIPPER, A. W. and J. L. FORNEY. 1965. Evaluation of partial fin clips for marking largemouth bass, walleyes and rainbow trout. New York Fish and Game Journal 12(2) : 233-240.

Partial fin clips did not produce an easily recognizable mark on the ventral fins of bass or on the pectoral, ventral, dorsal or anal fins of 5-inch rainbow trout. It seems likely that the conspicuousness of the mark produced by partial clipping varies with the relative size of the fish when marked. As an adjunct to complete fin removal, partial clipping increases the number of groups of fish that can be distinctly marked at one time. Adverse effects of fin mutilation on survival and behavior are probably minimized because initial injury is less severe and partially clipped fins usually regenerate rapidly. Partial clipping is a fast marking procedure that requires almost no training and no special equipment other than a pair of diagonal wire-cutting pliers.

EIPPER, A. W. and H. A. REGIER. 1962. Fish management in New York farm ponds. New York State College of Agriculture Cornell Extension Bulletin 1089. Ithica, New York. 39 p.

This publication is designed to address pond management issues such as construction, stocking of fish and the maintenance of the fish to insure adequate survival, growth and reproduction. Presently only two combinations are recommended for stocking in warmwater ponds, both involving the largemouth bass.

The bass-shiner combination involves the use of golden shiners and is recommended for coolwater and warmwater ponds intended for sport fishing for bass. Success should be achieved in ponds one-sixth of an acre and larger, with some weeds. The recommended ratio is 100 bass fingerlings (1- to 2-inches long) and 400 golden shiners (2.5- to 4-inches long) per surface acre. Although, survival varies from one pond to the next, in one experimental (unfished) pond bass were found to drop to 60 per acre five years after the initial stocking. With this combination shiner populations peak two years after stocking and following their extinction two to five years later, bass populations have been known to thrive on their own for up to three years. The total poundage of bass from an experimental pond, five years following stocking was 85 pounds per acre. It is advised that bass not be fished until two years following the stocking and only 22 bass per acre be taken during summers two through four.

The bass-bluegill combination is recommended for warmwater ponds larger than one-half acre and deep enough to control the weeds. One hundred bass fingerlings and 1,000 bluegill fingerlings should be stocked during the same summer. Bass harvests will likely be less in these ponds than in those with the shiner-bass combination. Research has showed that bass survival is lower in bass-bluegill ponds and it also takes four years for these bass to reach 10 inches. This slow growth usually occurs because the bluegills have a tendency to overpopulate the pond. At this time, little information is available concerning the planting of largemouth or smallmouth bass alone. However, a suggested stocking rate is 100 bass fingerlings per acre.

ELLAH, R. T. 1969. Adult fish transfer from Little Silver Lake to Otty Lake. Ontario Department of Lands and Forests. Kemptville, Ontario. 7 p.

The purpose of this report was to determine the costs involved in transferring adult fish from one lake to another. In this case Otty Lake received smallmouth and largemouth bass from Little Silver Lake. The bass population in Little Silver was crowded and stunted and it was predicted that the transplant would benefit both lakes. The operation was conducted from May 5 to May 15, 1969. Of the 169 bass transferred, 11.4% were smallmouth bass and 88.6% were largemouth bass. By taking into account wages and gas mileage, it was determined that the operation cost the Department $649.72 (Canadian).

EMIG, J. W. 1966$_a$. Largemouth bass. p. 332-353 *In* A. Calhoun [ed.]. Inland Fisheries Management. California Department of Fish and Game. Sacramento, California.

Pond stocking with largemouth bass is typically done in conjunction with one or more species and tends to vary from one state to the nest. In unfertilized California ponds 500 bluegill fingerlings and 50 largemouth bass fingerlings stocked per acre will yield favorable results, as should fifty bass fingerlings and 6 to 8 large redear sunfish per acre. In fertilized ponds numbers stocked should be doubled. The ratio varies slightly in Kentucky were a stocking of 80 to 100 bass fry and 500 bluegill fingerlings or 100 bass fry with 30 to 70 adult bluegills is recommended.

In more northern areas, such as New York, ponds are typically stocked with 500 or 1,000 bluegill fingerlings and 100 bass fry. Ohio uses 100 to 200 bass fingerlings and 1,000 bluegills to the acre. In Indiana redear sunfish are preferred over bluegills and stocking usually includes 100 redear fingerlings and 100 largemouth bass fingerlings per acre.

The size of the impoundment being stocked may have a significant impact upon fish production so it is important to take factors such as surface area into account when stocking. Impoundments greater than 100 acres can be stocked with 1 adult largemouth bass for each 3 to 20 acres, along with bluegill at a slightly higher rate. Satisfactory fishing can also be achieved in intermediate-sized bodies of water by planting 2 to 10 adult largemouth bass and 100 fingerling bluegills per acre.

EMIG, J. W. 1966$_b$. Smallmouth bass. p. 354-366 *In* A. Calhoun [ed.]. Inland Fisheries Management. California Department of Fish and Game. Sacramento, California.

Stocking fingerling smallmouth bass in Iowa lakes already containing populations of this fish did not increase populations or catches, unless plantings were excessively heavy (Moen 1960). One year after stocking 6- to 8-inch bass in Jordan Creek, Illinois, the population increased 34% and the number over 10 inches increased 60%. There was no indication the introduced fish caused a decline in the number of natives (Larimore 1954). Another study found that smallmouth bass stocked alone in a pond were successful, but their condition factor was lower than for those stocked with bluntnose minnows.

ENGLEHART, W. H. 1977. Retention of fluorescent pigment marks by two strains of largemouth bass. Transactions of the American Fisheries Society 108(1) : 64-66.

A study was performed to delineate zones of fluorescent pigment mark retention in northern (*Micropterus salmoides salmoides*) and Florida (*Micropterus salmoides floridanus*) largemouth bass and evaluate the frequency of mark retention of these zones. The caudal peduncle and caudal fin base retained the mark best; the head was the least retentive. The areas of best mark retention should be scanned in order to reduce observation time with large numbers of fish and reduce handling mortality.

ERDMAN, D. S. 1969. Puerto Rico fish surveys and investigations: Introduction of largemouth bass to a Tilapia pond at Rio Piedras to study predator control. Dingell-Johnson Project PR F-1-R-17, Job No. 14. Puerto Rico Division of Fisheries and Wildlife. Puerto Rico. 4 p.

ERICKSON, J. 1974. Evaluation of techniques to manage intensively used small impoundments. Dingell-Johnson Project OH F-29-R-13, Study No. 2, Final Report. Ohio Division of Wildlife. Columbus, Ohio. 28 p.

ERICKSON, J. 1979. Inland fisheries surveys: Stocking of yearling largemouth bass in Hargus and Richwood lakes. Ohio Division of Wildlife. Columbus, Ohio. 7 p.

FAJEN, O. F. 1981. Warmwater stream management with emphasis on bass streams in Missouri. p. 252-265 *In* L. A. Krumholz [ed.]. American Fisheries Society Warmwater Streams Symposium, March 9-11, 1980, Knoxville, Tennessee.

Most major warmwater stream systems have been drastically altered by man, so much so that in many cases one can only conjecture with respect to the qualitative and quantitative nature of the historic stream fauna.

The objective of the paper is to identify factors related to the maintenance and improvement of warmwater streams and to explore the possibilities of directing or controlling those factors to the benefit of the fisheries. Minimum length limits have been applied effectively to some warmwater stream fisheries. Other regulations such as bag limits, seasonal closures, and gear restrictions have played a lesser role.

Supplementary stocking of fingerling smallmouth bass to enhance year class recruitment has not proved useful in streams that provide a satisfactory environment for natural reproduction. Supplementary stocking may be useful in streams that are able to support adult fish but are deficient in spawning habitat. Smallmouth bass may be unable to compete successfully with introduced spotted bass in warmwater streams. The introduction of any exotic fish species should be preceded by careful analysis of the probable consequences.

FARQUHAR, B. W. 2000. The contribution of supplementally stocked Florida largemouth bass to a year class in three west Texas reservoirs during drought conditions. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

The contribution of stocked Florida largemouth bass fingerlings to their year class was evaluated in three reservoirs in the semi-arid region of West Texas. This region experiences periodic droughts, which lead to several consecutive years of declining water levels and a reduction in largemouth habitat and recruitment in these reservoirs. This study was designed to evaluate bass stockings during low water conditions. Florida largemouth bass fingerlings carrying a unique allele were stocked at an average rate of 132/ha in 1996. Electrofishing samples taken in the fall of 1996 and 1997 indicated marked fish comprised 77% of age 0 bass sampled in 1996 and 84% of age 1 bass sampled in 1997 in O.C. Fisher Reservoir. In Twin Buttes North Pool, marked fish made up 0% and 5% of the sampled bass in 1996 and 1997 respectively. Twin Buttes South Pool was intermediate with 13% of age 0 and 9% of age 1 bass sampled in 1996 and 1997 respectively being marked. Results indicate stocking under low water conditions may have been successful in altering the genetic composition of a bass population in one of three reservoirs; however, contribution to actual year class strength was not be determined from this study.

FERRIS, J. P. 1985. White Lake integrated resources management lake plan. Part I. Background information. File Report. Ontario Ministry of Natural Resources. Kemptville, Ontario. 93 p. + appendices.

White Lake was known as a major fishery in the past and it has the potential to regain that status through water and habitat rehabilitation. Although the lake is currently managed as a yellow pickerel fishery, the original native fish species composition is unknown. In 1903-1904 smallmouth bass were introduced into the lake, while largemouth bass were first introduced in 1957. Only largemouth bass and rock bass have increased in C. U. E. since 1960, and since their introduction the numbers of largemouth bass in the fishery have increased dramatically.

FIELDHOUSE, R. D. 1971. Results of stocking largemouth bass in Nassau Lake. New York Fish and Game Journal 18 : 68-69.

Nassau Lake, a 153-acre warm-water impoundment with a maximum depth of 11 feet, was formed by a 9-foot dam across the Valatie Kill in Rensselaer County (N. Y.). The lake is inhabited by largemouth bass, chain pickerel, and numerous panfish species of which white and yellow perch are the most abundant. Heavy blooms of algae are common, and an extensive fish kill during the late summer of 1962 may have resulted from rapidly decomposing algae.

For a number of years the Rensselaer County Conservation Alliance has reared largemouth bass in a 5-acre pond for stocking as fall yearlings in various lakes in the county. Approximately 25,000 largemouth bass fry were stocked in alternate years in the 5-acre pond. Survival of these bass until they were netted for stocking at the end of their second summer approached 50%. Golden shiners were used as forage fish.

Nassau Lake was stocked with 400 yearlings in 1960 and 5,073 in 1962. The fish ranged from 5.0 to 10.5 inches long, with an average length of 6.0 inches. Of the bass stocked, 200 in 1960 and 492 in 1962 were marked with jaw-tags. Only one tag from each year's stocking was returned. Because of this apparently poor contribution to angling, it was decided to monitor the survival of the bass stocked in the lake during 1966.

During the fall of 1966, 1,350 largemouth bass averaging 7.5 inches in length were marked by removing the left ventral fin and stocked into Nassau Lake. These were fish of the 1965 year class. Fish collections were made around the entire periphery of the lake with a boat shocker (230 volt D. C.) during May 1967, October 1968 and June 1969. Largemouth bass collected were measured and examined for marks, and scale samples were taken.

Of all the 1965 year-class collected, marked fish amounted to 41.7% in 1967, 35.7% in 1968 and 17.6% in 1969. The variability of the apparent contribution of stocked bass to the 1965 year class was probably associated with the small sample size or the increasing difficulty in recognizing marked fish with the passage of time. Bass stocked were of smaller average size than native bass of the same age. However, by their fifth year of life, the stocked bass appeared to have reached the size attained by the native fish. It is not known whether increased competition for food and space, as a result of stocking the additional bass was detrimental to the native bass population.

Considering the history of the few angler returns for bass stocked in Nassau Lake, and the good native bass population, an annual stocking program is of questionable value. Largemouth bass stocked as fall yearlings could make a significant contribution to the bass population if the stocking coincided with the presence of a weak corresponding year class of native bass. In practice, this would be difficult to accomplish.

It is problematical whether a similar stocking program would be of value in a lake with a relatively small largemouth bass population. Stocking fall yearlings might be worthwhile if a lack of natural spawning success and/or a low survival rate among young-of-year and yearling bass were factors limiting the size of the population. Creel census information and comprehensive knowledge of the size and dynamics of the native bass population would be necessary to adequately evaluate such a stocking program.

FILIPEK, S. P. and M. D. GIBSON. 1986. Evaluation of supplemental stocking of largemouth bass in Coronado, Arkansas. p. 313 *In* G. E. Hall and M. J. Van Den Avyle [eds.]. Reservoir Fisheries Management: Strategies for the 80s. Southern Division, American Fisheries Society. Bethesda, Maryland.

Hatchery-spawned largemouth bass (*Micropterus salmoides*) 1.5-2.0 in total length are stocked in selected Arkansas reservoirs in the spring to supplement poor survival of natural bass spawns. To evaluate this management technique, 20,000 fingerling largemouth bass with a mean total length of 1.96 in were marked with fluorescent pigment sprayed into the epidermis of the fish. These fish were stocked into a 384 acre reservoir at a rate of 50 bass per acre. It had earlier been determined that this lake experienced a poor natural spawn of bass. Seining, electrofishing, and cove rotenone sampling were used to monitor the total young-of-year size class made up of hatchery stocked bass. After stocking in June, these fish initially composed 17.2% of the 1981 year class. In August, hatchery bass comprised 90% of the 1981 year class. By September, hatchery bass made up 36% of the year class, and they comprised 10% of the young bass crop in October.

After October, mark retention in a pond of control fish dropped off to approximately 50% and the lake sampling was discontinued. Black bass smaller than 3 in total length apparently do not retain the fluorescent pigment as long a larger fish due to incomplete scale formation at that age. During the June-October time period, hatchery bass were longer than their lake-spawned counterparts. Hatchery bass were also slightly larger than bass in a similar nearby control lake that had experienced an adequate bass spawn and higher forage spawns. Intermediate bass ranging from 6 to 8 in total length were 3.6 times more abundant in fall rotenone samples approximately 15 months after stocking, and almost one-third of these were hatchery-stocked bass.

FINDLAY, C. S., D. G. BERT and L. ZHENG. 2000. Effect of introduced piscivores on native minnow communities in Adirondack lakes. Canadian Journal of Fisheries and Aquatic Sciences 57 : 570-580.

We compared the minnow assemblages of Adirondack lakes with top piscovores with those of lakes having similar physiochemical and biotic characteristics but not top piscovores using a subset of data collected from 1984 to 1987 by the Adirondack Survey Corporation. Native minnow richness in lakes with top piscivores was about one third that of lakes without piscivores, with piscivore assemblages dominated by introduced species such as northern pike (*Esox lucius*), largemouth bass (*Micropterus salmoides*), and smallmouth bass (*M. dolomieu*). There was strong evidence that at least four minnow species, including creek chub (*Semotilus atromaculatus*), northern redbelly dace (*Phoxinus eos*), blacknose dace (*Rhinichthys atratulus*), and common shiner (*Luxilus cornutus*), were less likely to occur in lakes with piscivores; for a fifth species – pearl dace (*Margariscus margarita*) – the evidence is suggestive but not as strong. Of 13 minnow species, only for nonnative species – bluntnose minnow (*Pimephales notatus*) and golden shiner (*Notemigonus crysoleucas*) – was there strong evidence that their occurrence was unaffected by the presence of introduced piscivores. These results add to the growing body of evidence that the introduction of top piscivores to small temperate lakes puts native minnow communities at high extinction risk.

FINNELL, J. C. 1956. Comparison of growth rates of fishes in Springtown Sub-Prison Lake prior to and three years after draining and restocking. Proceedings of the Oklahoma Academy of Science 35 : 30-36.

FISHER, R. 1971. The initial stock of fish produces spectacular fishing. p. 211-213 *In* R. J. Muncy and R. V. Bulkley [eds.]. Proceedings of the North Central Warmwater Fish Culture and Management Workshop. Iowa Cooperative Fisheries Unit, January 21-22, 1971, Ames, Iowa.

FLEENER, G. G. 1956. Intensive creel census of two similar smallmouth bass streams. Dingell-Johnson Project MO F-1-R-5, Job No. 1. Missouri Conservation Commission. Jefferson City, Missouri. 31 p.

FLEENER, G. G. 1968. The fishery of Current River, the effect of tributary stocking on the fishery of an Ozark stream. Dingell-Johnson Project MO F-1-R-17, Job No. 3. Missouri Conservation Commission. Jefferson City, Missouri. 15 p.

FLEENER, G. G. and J. L. FUNK. 1958. Fisheries management planning and research: Intensive creel census of an Ozark stream stocked annually with smallmouth bass. Dingell-Johnson Project MO F-1-R-7, Job No. 1. Missouri Conservation Commission. Jefferson City, Missouri. 21 p.

FLEENER, G. G., J. L. FUNK and P. E. ROBINSON. 1974. The fishery of Big Piney River and the effect of stocking fingerling smallmouth bass. Missouri Department of Conservation Aquatic Series No. 9. Jefferson City, Missouri. 32 p.

The Big Piney River is a spring-fed, clear, hard-water stream. Sixty-nine species of fishes were collected including black redhorse, golden redhorse, smallmouth bass, longear sunfish, rock bass, hog suckers, green sunfish, gizzard shad, northern redhorse, carp and channel catfish. The Ozark minnow, bleeding shiner, northern studfish, stoneroller, and bluntnose minnow were the most important forage species. Averages for 8 years of pounds of fish taken per 10 hours of electric shocking varied from 133 to 238. Drought had no discernable effect on catch rates. Average total lengths of smallmouth bass at the end of various years were: 1, 3.4 inches; 2, 6.3; 3, 8.5; 4, 10.6; 5, 12.8; 6, 14.9; 7, 16.2; 8, 17.1 and 9, 17.5.

The fishery of the Big Piney was diversified with 69% of the anglers still fishing, 28% casting and 2% fishing set lines. Each year longear sunfish, rock bass, green sunfish and smallmouth bass made up about 90% of the catch. Fishing pressure varied from 52.5 to 111.3 hours per acre. The average annual yield of fish was 21.9 pounds per acre of which 4.2 pounds per acre was smallmouth bass. Most smallmouth bass were caught before they had completed their fourth year of life and less than 5 years old. There appeared to be a direct correlation between the number of young bass surviving the first summer and the number of fish the year class contributed to the creel.

Over 92,000 marked fingerling smallmouth bass were stocked 1952-1955. An estimated 63,600 smallmouth bass were caught between 1953, when the first stocked fish entered the creel, and 1958 when no more marked fish were caught. Of that number, not more than 2,100 were stocked fish. This is a little more than 3% of all the bass caught and little more than 2% return of stocked fish.

FOLLIS, B. J. 1974. Fisheries studies, Region 1-B: Fish stocking evaluation. Dingell-Johnson Project TX F-5-R-22, Job No. 14. Texas Parks and Wildlife Department. Austin, Texas. 11 p.

FONG, S. 1979. Dynamics of bass-bluegill populations in farm ponds. Ph. D. Dissertation, Auburn University. Auburn, Alabama. 144 p.

FORNEY, J. L. 1964. Marking of walleyes and smallmouth bass – routine sampling of Oneida Lake fish populations. Dingell-Johnson Project NY F-17-R-8, Job I-A. New York State Division of Fish and Game. Ithica, New York. 34 p.

A total of 448 smallmouth bass collected by electrofishing near Shackleton Point were jaw-tagged. Three hundred were released at Shackleton Point and 148 were released eight miles from Shackleton Point to study the effect of displacement from home territory on vulnerability to angling.

FORNEY, J. L. 1972. Biology and management of smallmouth bass in Oneida Lake, New York. New York Fish and Game Journal 19(2) : 132-154.

Age composition and growth rate of smallmouth bass in Oneida Lake were determined from scales and measurements collected from 1952 to 1970. Dominant year classes were produced in years when mean June air temperatures were above normal. The catch of young bass in seine hauls indicated that year-class size was established by August, but the causal relation between June air temperature and year-class survival was not established.

Experimental stocking took place between 1964 and 1966 to determine the contribution of stocked smallmouth bass to the fishery. In September of 1964, 1965 and 1966 about 10,000 smallmouth bass with a mean length of 2.2 inches were released along a two mile section of shoreline bordering Shacklelton Point. These hatchery fingerlings were identified by clipping the right ventral fin in 1964 and 1966 and the left ventral in 1965. The contribution of stocked fish to each year class was determined from the number of marked bass in samples collected by electrofishing near Shackleton Point from 1967 to 1970.

The ratio of marked to unmarked bass in samples of the 1964, 1965 and 1966 year classes was 0.41, 0.69 and 0.03, respectively. The large number of young originating from natural reproduction in 1966 was probably responsible for the low contribution of stocked fingerlings to this year class. The catch of bass in seine hauls in August before stocking was 2.5 per haul in 1966 compared with 0.08 and 0.04 in 1964 and 1965. Since about the same number of fingerlings were stocked each year, the contribution of these fingerlings to the 1966 year class would be low although the number recruited to the adult population was probably comparable to that in 1964 and 1965.

Marked fish released from 1964 to 1966 comprised only 6% of the electrofishing catch in 1969 and a lower percentage in 1970. Dispersal of fingerlings from the stocking area and regeneration of clipped fins may have contributed to the low recoveries of marked fish. However, it appears that massive stocking would be required to substantially increase the population density in Oneida Lake. The value of stocking young smallmouth bass in established populations has been questioned by Moen (1960) and others.

The long-term average growth rate of bass was stable between 1949 and 1966, but annual growth increments varied markedly. Much of this variation was attributable to differences in mean summer air temperatures and the abundance of young yellow perch which were an important forage species.

Annual survival and minimum rates of exploitation were determined from tag returns reported by anglers. The mean annual survival during a 14-year period was 0.57 which agreed closely with estimates from catch curves. A linear regression was fitted to annual survival rates and minimum rates of exploitation to obtain an estimate of natural mortality. The intercept in the event of no fishing corresponded to a natural mortality rate of 0.125. The role of regulations and stocking in the management of the population is examined.

FORSHAGE, A. A. and L. T. FRIES. 1995. Evaluation of the Florida largemouth bass in Texas, 1972-1993. American Fisheries Society Symposium 15 : 484-491.

The creation of lentic habitats in Texas by reservoir construction provided the impetus to introduce a fish that was assumed to be better adapted to the new conditions. Based on reported faster growth, greater maximum size, and potentially increased fitness in lentic habitats of the Florida largemouth bass (*Micropterus salmoides floridanus*) compared with the native largemouth bass (*M. salmoides salmoides*), the Texas Parks and Wildlife Department has stocked Florida largemouth bass into selected Texas waters since 1972. The overall goal of these stockings was to maximize quality recreational fishing for largemouth bass. Population genetics studies conducted in 1991 through 1993 on 126 reservoirs stocked with Florida largemouth bass suggest that introductions have had varying success. Electrophoresis of loci exhibiting fixed differences between the subspecies (*AAT-B** and *sIDHP**) indicated an average of 36.3% occurrence of Florida largemouth bass alleles. Ninety-one reservoirs had a frequency of Florida largemouth bass alleles 20% or greater; six had 0% occurrence. In seven reservoirs, Florida largemouth bass virtually replaced northern largemouth bass with almost complete fixation (> 80%) of the Florida largemouth bass alleles. Linear models suggest Florida largemouth bass stocking success is lower in older reservoirs, reservoirs in northern latitudes, and larger reservoirs. Establishment of Florida largemouth bass alleles is increased through repeated annual stockings. Florida largemouth bass stockings also have affected largemouth bass angling. Since their introduction, the state record largemouth bass increased from 6.12 to 8.25 kg. Mean weight for largemouth bass submitted to the Big Fish Awards program increased from a low of 3.93 kg in 1977 to a high of 5.41 kg in 1991. The number of reservoirs yielding trophy largemouth bass (> 4.54 kg) increased from 2 in 1974 to 35 in 1993. The increase in trophy largemouth bass catches is considered positive by Texas anglers and fishery managers.

FORSHAGE, A. A. and B. A. GREGG. 1988. Evaluation of the Florida largemouth bass in texas, 1972-1987. Presented at the Annual Meeting of the American Fisheries Society 118 : 77. (Abstract only)

The Texas Parks and Wildlife Department has been involved in the evaluation of the Florida largemouth bass (*Micropterus salmoides floridanus*) since its introduction into Texas in 1972. This presentation will assess this introduction after 15 years of stocking. Included will be a review of the history of the program's management and stocking strategies and analyses of the impact of Florida largemouth bass on the genetic makeup of largemouth bass populations and trophy bass harvest. Electrophoretic analyses conducted since 1979 on 27% of stocked reservoirs are used to assess relationships between reservoir characteristics and stocking strategies and the occurrence of Florida bass alleles. In addition, increases in trophy bass harvest as documented by angler recognition programs (big fish award, state record) are analyzed as a function of Florida largemouth bass stockings. The results indicate that introducing the Florida largemouth bass has improved the quality of largemouth bass fisheries.

FREUD, J. G. and K. J. HARTMAN. 1999. Evaluation of a pilot largemouth bass (*Micropterus salmoides*) stocking program using radio telemetry. From the 1999 Southern Division of the American Fisheries Society Mid-Year Meeting. Chattanooga, Tennessee. (Abstract only)

Due to the perceived long-term reduction in the quality of the largemouth bass fishery in the Ohio River, many angling organizations are pressing the West Virginia Department of Natural Resources to stock largemouth bass in the Ohio River. Radio telemetry was used to analyze the success of a pilot largemouth bass (*Micropterus salmoides*) stocking in embayments of the Ohio River. Six adult largemouth bass obtained from a hatchery were implanted with 8-gram radio transmitters. Twenty adult largemouth bass captured through electrofishing and bass tournaments in the Belleville Pool of the Ohio River were fitted with radio transmitters of two percent or less of their body weight. The Belleville Pool is a 70.5-km navigation pool formed by the Belleville Lock and is bordered by the states of Ohio and West Virginia. Due to the size of the Ohio River, stocking sufficient numbers of bass to produce what anglers would perceive, as a "quality" fishery is not feasible. Therefore fish were stocked into smaller embayments of the Ohio River and mortality, habitat preference, and seasonal movement were compared between the wild and stocked fish. In this paper, we discuss and compare these parameters between wild and stocked fish in light of the criteria that for a stocking program to be successful mortality of stocked bass should not be significantly greater than wild bass mortality and stocked bass must contribute to the spawn.

FRIES, L. T., G. L. KURTEN, J. ISSAC, Jr., T. ENGLEHART and D. LYON. 2000. Mass production of triploid Florida largemouth bass for stocking public waters in Texas. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

Largemouth bass (*Micropterus salmoides*) is among the most sought after and highly managed species of sport fish in North America. Because it attains a larger maximum size than the northern subspecies (*M. s. salmoides*) the Florida largemouth bass subspecies (*M. s. floridanus*) has been widely stocked outside its native range, particularly in the southern United States. This has resulted in widespread introgression between the two subspecies outside the natural intergrade zone. In some situations, it may be beneficial to keep introgression from occurring. One way to maintain discrete genomes within a single fishery is to use non-reproductive individuals, such as triploids, in stocking programs. In 1996, the Texas Parks and Wildlife Department (TPWD) began stocking selected water bodies with triploid Florida largemouth bass fingerlings. Triploid largemouth bass are produced by hand stripping gametes and applying hydrostatic pressure shortly after fertilization. Methods have been refined such that production has increased dramatically between 1996, when a total of 1,169 were produced, and 1998, when approximately 25,000 triploid fingerlings were produced. The TPWD currently is working to develop a tetraploid broodstock, which may further increase production numbers.

FRUETEL, M. 1995. Smallmouth bass and walleye interactions in Northwestern Ontario lakes. p. 15-16 *In* P. MacMahon [ed.]. Northwest Science and Technology Workshop Proceedings WP-003, October 24-25, 1995, Thunder Bay, Ontario.

The introduction of the smallmouth bass began in the northwestern area of Ontario in the early 1900s. Since this time the species has become distributed throughout the region. There has been much speculation that smallmouth bass can cause the collapse of walleye populations. In the early to mid-1900s smallmouth bass were introduced to Shoal and Rainy lakes and both waterbodies appeared to experience a decline in walleye numbers. However, the lag of the walleye collapses was not in time with the increases in smallmouth bass abundance, and therefore the new species did not appear to be responsible for the declines. Crooked Pine Lake, where smallmouth bass were first observed in 1982, has experienced fluctuating walleye populations. Apparently, whenever smallmouth bass have a strong year-class, the walleye experience a weak one, and vice versa.

In northwestern Ontario there is little evidence to support the notion that smallmouth bass have a direct negative effect on walleye populations. It is possible that healthy walleye populations are less effected by the introduction of the smallmouth bass and can remain highly competitive.

FULLERTON, A. H., J. E. GARVEY, R. A. WRIGHT and R. E. STEIN. 2000. Overwinter growth and survival of largemouth bass: Interactions among size, food, origin, and winter severity. Transactions of the American Fisheries Society 129(1) : 1-12.

Winter severity (temperature, duration, and photocycle), geographic origin, food availability, and initial body size likely influence growth, survival, and therefore, recruitment of age-0 largemouth bass (*Micropterus salmoides*). We collected age-0 largemouth bass (70-160 mm total length) from low (33°N), intermediate (40° N), and high (45° N) latitudes throughout their natural range (origin), and we subjected all three groups of fish to three experimental winters that mimicked these latitudes ($N = 9$ largemouth bass per treatment). Within each winter and origin, one-half of the largemouth bass were fed fish prey, whereas the remaining one-half were starved. Winter strongly influenced survival: Overall survival rates in the high-, intermediate-, and low-latitude winters were 34.9, 59.4 and 61.1%, respectively (x^2 test, $P < 0.05$). Largemouth bass from 33° N suffered high mortality in the high-latitude winter. Across all winters, more fed fish (64.5%) survived than did starved fish (38.1%) (x^2 test, $P < 0.05$). Pooling fish into small (< 100 mm) and large (> 100 mm) size classes revealed that more small fish died than did large fish in the low- and high-latitude winters, but this was not the case in the middle-latitude winter. Wet weights (g) of fed largemouth bass increased, remained constant, and declined in the low-, intermediate-, and high-latitude winters, respectively. Wet weight and total energy content (kJ) of fed individuals were consistently higher than those of their starved counterparts in all winters. However, energy density (kJ/g) of fed individuals often declined to levels similar to those of starved largemouth bass. Winter temperature combined with duration likely dictates the northern limit of largemouth bass by reducing growth, even when food is abundant. Because survival of individuals from the low latitude was poor in higher latitude winters, stocking southern largemouth bass in northern systems may translate to high mortality and perhaps to degradation of physiological tolerances of local populations through hybridization.

FUNK, J. L. [ed.]. 1974. Symposium on overharvest and management of largemouth bass in small impoundments. Northcentral Division of the American Fisheries Society, Special Publication 3. Bethesda, Maryland. 116 p.

The symposium entitled "Largemouth Bass Overharvest – Fact or Fiction," was presented at the 34th Midwest Fish and Wildlife conference in Des Moines, Iowa, on December 12, 1972 with the primary objective of introducing papers related to the overharvest and management of largemouth bass.

FUNK, J. L. and G. G. FLEENER. 1973. The fishery of a Missouri Ozark stream, Big Piney River, and the effects of stocking fingerling smallmouth bass. Dingell-Johnson Project MO F-1-R-22, Job No. 1-E. Missouri Department of Conservation. Jefferson City, Missouri. 46 p.

FUNK, J. L. and G. G. FLEENER. 1974. The fishery of a Missouri Ozark stream, Big Piney River, and the effects of stocking smallmouth bass. Transactions of the American Fisheries Society 103(4) : 757-771.

Over 92,000 marked fingerling smallmouth bass were stocked in the Big Piney River, 1952-1955. An estimated 63,600 smallmouth bass were caught between 1953, when the first stocked fish entered the creel, and 1958 when no more marked fish were caught. Of that number, not more than 2,100 were stocked fish. This is a little more than 3% of all the bass caught and a little more than 2% return of stocked fish.

Seventy species of fish were collected between 1951 and 1958 with electroshockers, hoopnets, and seines. Golden redhorse, rock bass, black redhorse and northern hog sucker, smallmouth bass and longear sunfish made up 80% of the total weight. The Ozark minnow, bleeding shiner, northern studfish, stoneroller, and bluntnose minnow were the most important forage fish. This species composition is representative of Ozark headwater streams. Mean annual catch rates ranged from 35.2 to 134.9 kg/10 shocker hours of which 2.3 to 13.6 kg/10 shocker hours were bass. Big Piney River is subject to flash floods with crests up to 6 m above base level. A drought which caused cessation of flooding permitted a record year-class of smallmouth bass to be produced in 1952. This large year-class contributed substantially to the fishery but complicated interpretation of the stocking data.

Fishing pressure measured by a creel census varied from 130 to 275 hr/ha per year. Annual yield of fish ranged from 9.0 to 29.8 kg/ha. Each year longear sunfish, rock bass, green sunfish, and smallmouth bass made up about 90% of the catch. Less than 5% of the smallmouth bass caught were more than five years old. Virtual populations of smallmouth bass varied from 5,600 (1950) to 24,600 (1952) fish. There appeared to be a direct correlation between the number of young bass surviving the first summer and the number of fish the first year-class contributed to the creel. Big Piney River yielded a greater quantity of fish to the fisherman than most other warmwater streams, many trout streams, and some warmwater lakes and reservoirs. The quality of the fishery declined under continued fishing pressure over 250 hr/ha per year.

GASAWAY, C. R. 1968. Comparison of bass-bluegill and bass-redear sunfish stocking in Oklahoma farm ponds. Proceedings of the Oklahoma Academy of Science 47 : 397-406.

GEIHSLER, M. R. and D. R. HOLDER. 1983. Status of fish populations in Georgia ponds 1-4 years after stocking. North American Journal of Fisheries Management 3(2) : 189-196.

Two hundred and twenty-five randomly selected Georgia ponds stocked with bluegill (*Lepomis macrochirus*), redear sunfish (*Lepomis microphus*) and largemouth bass (*Micropterus salmoides*) from state hatcheries in 1975-1976 were surveyed 1 year after stocking largemouth bass to determine the state of balance of their populations and the key factors associated with unbalanced ponds. The same ponds were examined again 4 years later. The percentage of balanced ponds 1 year after stocking, from analyses of seine catches in 205 of the ponds, was 31%; 4 years after stocking it was 37%. These two percentages were not significantly different. Poor physical features and improper fertilization practices were significant factors in unbalanced ponds. Time of stocking was significant for ponds in temporary balance. Recommended improvements in the state's pond-stocking program included stocking at the unfertilized rate, performing pre-stocking evaluations, improving the quality of information recorded on fish applications, stocking ponds earlier, and providing more information to owners about proper pond construction.

GELWICK, F. P., E. R. GILLILAND and W. J. MATTHEWS. 1995. Introgression of the Florida largemouth bass genome into stream populations of northern largemouth bass in Oklahoma. Transactions of the American Fisheries Society 124(4) : 550-562.

Oklahoma streams and reservoirs historically contained only the northern subspecies of largemouth bass (*Micropterus salmoides salmoides*). From 1970 to 1991 Oklahoma reservoirs throughout the state were supplementally stocked with the Florida subspecies (*M. s. floridanus*) and various intergrades of the northern and Florida subspecies. To document the effect of such introductions on the genetic structure of largemouth bass stream populations, largemouth bass throughout Oklahoma were sampled by seining. Electrophoretic analysis was carried out for loci that code the enzymes isocitrate dehydrogenase (sIDHP), aspartate aminotransferase (sAAT-B), and superoxide dismutase (sSOD). These three loci are diagnostic for Florida largemouth bass. Analysis was also carried out for loci that code the enzymes malate dehydrogenase (sMDH-A and sMDH-B), phosphoglucomutase (PGM), and glucose-6-phosphate isomerase (GPI-A and GPI-B). These five loci are known to be polymorphic in largemouth bass. Overall, Florida-subspecific alleles were found in 4% of the fish collected and at 11% of the sites that held largemouth bass. Combined frequencies of Florida-subspecific alleles ranged from 0.00 to 0.18; highest frequencies were in the southeastern half of Oklahoma. Overall genetic variability was highest among streams of the Red River basin, and sMDH-B* was the most variable locus. Low mean F_{st} values (standardized variances of allele frequencies) around 0.08 indicated little differentiation among streams. Two distance matrices based on allele frequencies (one derived from the total data set and one from a subset that excluded individuals with Florida-subspecific alleles) showed significant correlation (approximate mantel *t*-test, $P < 0.0001$). This indicated that the genetic relationships among all stream populations as a whole were not significantly influenced by individuals with Florida-subspecific alleles. Allele frequencies that were not in Hardy-Weinberg equilibrium (HWE) and heterozygote deficiencies at the sIDHP* and sAAT-B* loci in introgressed populations suggested that the main influence of introgression was localized within the individual stream systems. However, the finding of HWE in the population with the highest rate of introgression may have indicated a freely interbreeding mixture in that stream system.

GILBRAITH, D. M. 1987. Evaluation of largemouth bass and bluegill stocking strategies in South Dakota ponds. M. Sc. Thesis, South Dakota State University. Brookings, South Dakota. 61 p.

GILLILAND, G. 1991. *Micropterus* bass investigations: Evaluation of reservoir-strain smallmouth bass. Oklahoma Department of Wildlife Conservation. Oklahoma City, Oklahoma. 56 p.

GILLILAND, E. R. 1994. Experimental stocking of Florida largemouth bass into small Oklahoma reservoirs. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 46(1992) : 487-494.

Thirteen Oklahoma reservoirs (< 120 ha) containing northern largemouth bass (*Micropterus salmoides salmoides*) populations were stocked with Florida largemouth bass (*M. s. floridanus*) for three years. Stocked and native fish were identified phenotypically by electrophoresis. Stocked fish made up an average of 15% of each year class in the fall at age 0, but the mean proportion declined to 5% by the following spring. Relative overwinter survival to age 1 averaged 25%. Florida largemouth bass were significantly longer at age 0 and age 1 than the northern subspecies but had significantly lower mean relative weights. Survival, mean length, and mean relative weight of Florida genotpyes were lowest in study lakes in the northern and western portions of Oklahoma, indicating that climatic factors were very influential. A recommendation was made to discontinue Florida largemouth bass stockings in Oklahoma north of a diagonal boundary from southwest to northeast. This would limit stockings of hatchery production to areas of the state that show the greatest potential for producing trophy bass.

GILLILAND, E. R. and J. BOXRUCKER. 1995. Species-specific guidelines for stocking reservoirs in Oklahoma. p. 144-151 *In* H. L. Schramm, Jr. and R. G. Piper [eds.]. Uses and Effects of Cultured Fishes in Aquatic Ecosystems. American Fisheries Society Symposium 15, 12-17 March 1994, Albuquerque, New Mexico.

The Oklahoma Department of Wildlife Conservation established stocking guidelines in 1990 for largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieu*), hybrid striped bass female (*Morone saxatilis* x male *M. chrysops*), walleye (*Stizostedion vitreum*), saugeye female (*S. vitreum* X male *S. canadense*), and channel catfish (*Ictalurus punctatus*). Committees composed of management, research, and hatchery biologists established systems by species that assigned points for various physical and biological criteria and fisheries characteristics of candidate reservoirs. Reservoirs were then ranked according to point totals and hatchery production was assigned in order of priority until fully allocated. Guidelines also included flowcharts to assist managers with stocking decisions, provided target values for the required evaluation sampling, and offered guidance on when to consider discontinuing stocking. Reservoirs that were stocked for three consecutive years and failed to meet evaluation criteria for the stocked species were removed from consideration, thus allowing new reservoirs to be considered based on their point rankings. The mean number of lakes for which stocking was requested (all species) decreased from 243/year for the 5 years before implementation of the guidelines to 186/year for the next 5 years. The mean number of reservoirs stocked declined by 30%, except those receiving smallmouth bass and saugeye, which increased by 85 and 150%, respectively. Mean numbers of fish stocked per year increased from 15,317,000 in 1985-1989 to 19,766,000 in 1990-1993. This increase was attributed to a large increase in walleye fry stockings that offset decreased numbers of stocked fingerlings of other species. The reservoir selection criteria were modified annually as the effectiveness of the system was tested. These guidelines proved useful to fishery managers by providing objective criteria to establish priorities for fish stocking. They also allow hatcheries to set realistic production goals by stocking only those reservoirs most likely to produce successful fisheries. The size and quality of stocked fish were also improved by shifting production demands.

GILLILAND, E. R., R. HORTON, B. HYSMITH and J. MOCZYGEMBA. 1989. Smallmouth bass in Lake Texoma, a case history. p. 136-142 *In* D. C. Jackson [ed.]. The First International Smallmouth Bass Symposium, August 24-26, 1989, Nashville, Tennessee.

The life history of the smallmouth bass (*Micropterus dolomieui*), the development of their population, and their contribution to recreational angling was monitored in Lake Texoma for 7 years after their introduction in 1981. Survival of stocked smallmouth bass was confirmed in 1982, and natural reproduction was documented in 1985. Electrofishing catch per unit effort for smallmouth bass increased four-fold from 1982 to 1988. They were initially collected near stocking sites, and by 1988, were collected up to 12 km from those sites in areas with habitat characterized by riprap or large rock. Their diet consisted of fish (74% by volume), crayfish (22%), and insects (4%). Growth of age-1 and older smallmouth bass was equal to, or exceeded, that reported for most other populations. By 1987, a sport fishery had developed and smallmouth bass in excess of 2.75 kg had been caught by anglers.

GILLILAND, E. R. and J. WHITAKER. 1989. Introgressions of Florida largemouth bass introduced into northern largemouth bass populations in Oklahoma reservoirs. Proceedings of the Annual Conference of Southeastern Association of Fish and Wildlife Agencies 43 : 182-190.

Populations of largemouth bass (*Micropterus salmoides*) in Oklahoma reservoirs were sampled in 1986 and 1987 to determine the degree of introgression of Florida largemouth bass (*Micropterus salmoides* *floridanus*) introduced over a sixteen year period into populations of native northern largemouth bass (*M. s. salmoides*). Florida subspecific alleles were present in 28 of 30 populations (93%) and were found in > 50% of the fish from 8 (27%) reservoirs. Correlations with selected physical and biological parameters indicated that the percentage of bass with Florida alleles increased as the size of fish stocked increased and as cold weather and water level fluctuation decreased. Reservoirs in southern portions of the state with stable water levels that were stocked with fingerlings > 100 mm in length at rates > 25/ha for several consecutive years had the highest degrees of Florida allele introgression into existing bass populations.

GLIDEN, E. 1931. Spiny-rayed fish, San Diego County lakes. California Fish and Game 17(1) : 89-90.

In 1888, the first introduction of the largemouth black bass was made into Cuyamaca Lake, according to the California Fish and Game Commission. Since this initial introduction, the offspring of the original stock have been transplanted to other San Diego County lakes resulting in the greatest bass fishing in California. The fish have been introduced into Sweetwater, Moreno, Hodges, the Upper and Lower Otay, Murray, Grossmont, Lindo, Henshaw, and Wolford lakes where they now thrive. The bass in these lakes exhibit rapid growth and weigh, on average, 1 to 8 pounds.

An attempt to stock smallmouth bass into Lake Wolford ended in disaster when the water received an overdose of bluestone or coppersulphate, thus killing all life. In 1925, however, largemouths were introduced and now provide wonderful fishing.

Currently the laws regulating bass fishing are loose. I should like to see a later opening and earlier closing season in order to protect these fish and ensure that they remain abundant.

GOODMAN, B. 1991. Keeping anglers happy has a price: Ecological and genetic effects of stocking fish. Bioscience 41(5) : 294-299.

Introduced fish species play an important role in North America's ecosystem. It is estimated that 140 species have been established outside their native range and 40 of these species are exotics. The negative effects that the introduced fish are having on native populations has finally taken center stage. In the case of introduced black bass species, the genetic integrity of other closely related stocks and species are being compromised. In Texas, smallmouth bass were stocked in reservoirs to provide larger game fish (as opposed to the Guadalupe bass). Unfortunately, some bass escaped and hybridized with the Guadalupe bass. The hybrids are fertile and also backcross with the parents. This has lead to the disappearance of the Guadalupe bass. Currently, only a few wild populations remain and a population had to be stocked outside its native range as a refuge.

GOUDREAU, C. J. 1998. Creating a fishery in the Bridgewater Tailrace, North Carolina. Presented at the 1998 Southern Division of the American Fisheries Society mid-year Meeting. Lexington, Kentucky. (Abstract only)

Studies in 1993 documented the existence of 46 fish species in the 29-km section of Catawba River between Lake James and Lake Rhodhiss, but game species were rare. Water chemistry parameters were considered to be normal. Water temperature ranged from 8-22o C, and low (< 5 mg/L) dissolved oxygen concentrations were restricted to a 3-km river segment from August - September. The lack of game fish was felt to be limited by reproductive success, possibly due to significant sediment input from a major tributary. In an attempt to establish fishable game fish populations, annual stockings of 30,000 fingerling smallmouth bass (1994-1997) and brown trout (1996-1997) were made. Boat electrofishing conducted in September 1996 and 1997 was limited, preventing the calculation of fish density or survival. Age and growth information determined from scales in 1996 were suspect, especially for brown trout which showed 1-2 false annuli. Calculations from otoliths in 1997 indicated growth of smallmouth bass was slow (206 mm at age 3) but very fast for brown trout (246 mm at age 1). W_r was high for smallmouth bass under stock size (mean 102), but declined for quality fish (mean 92). Mean W_r was 82 for brown trout under stock size, increasing to 95 for preferred fish. Stocking and fish and habitat sampling will continue for several more years to determine which species is best suited for local conditions.

GRAHAM, L. K. 1969. Harvest management in ponds. Dingell-Johnson Project MO F-1-R-18, Job No. 8. Missouri Conservation Commission. Jefferson City, Missouri. 17 p.

GRAHAM, L. K. 1970$_a$. Harvest management in ponds. Dingell-Johnson Project MO F-1-R-19, Job No. 8. Missouri Conservation Commission. Jefferson City, Missouri. 21 p.

GRAHAM, L. K. 1970$_b$. Evaluation of several stocking combinations for ponds. Dingell-Johnson Project MO F-1-R-19, Job No. 7. Missouri Conservation Commission. Jefferson City, Missouri. 8 p.

GRAHAM, L. K. 1971$_a$. Fisheries management planning and research: Review of literature on Florida largemouth bass introductions. Dingell-Johnson Project MO F-1-R-20, Job No. 1-I. Missouri Department of Conservation. Jefferson City, Missouri. 13 p.

Literature compares the age and growth, morphological, morphometric and vulnerability of the Florida largemouth bass to that of the northern largemouth bass.

GRAHAM, L. K. 1971$_b$. Fisheries management planning and research: The study of pond fish stocking combinations. Missouri Department of Conservation. Jefferson City, Missouri. 16 p.

Growth of largemouth bass from various stocking rates is discussed.

GRAHAM, L. K. 1972. Effects of four harvest rates on pond fish populations. p. 29-38 *In* J. L. Funk [ed.]. Symposium on Overharvest and Management of Largemouth Bass in Small Impoundments. American Fisheries Society Special Publication No. 3. Bethesda, Maryland.

Largemouth bass, bluegills, and channel catfish, stocked in 1967 to simulate a 2-yr-old pond fish population, were harvested each year from 1968 to 1970 at various rates (0, 20, 40 and 60%) and the resulting fish populations were analyzed. The best average bass growth for 1968 and 1969 took place in the 40% harvest ponds. However, because of the large harvest in the 60% harvest ponds, the small numbers of large bass remaining in these ponds in 1970 grew faster than fish in any other pond. The most desirable bass populations were found in the 40% harvest ponds. The 0% harvest ponds were overcrowded with slow-growing bass, the catchable-size bass in the 60% harvest ponds were practically gone and there was a large buildup of slow-growing intermediate-size bass. Original stock bass in the 20% harvest ponds grew well but there was a shortage of intermediate-size fish in these ponds. Bluegill populations were similar in all ponds. Their growth above 6-in total length was slow. Catfish did not reproduce successfully in any pond, therefore, their growth was directly proportional to rates of harvest. Standing crops of all fish in harvested ponds in 1968 were highest in the 40% harvest ponds, but the highest standing crops in 1969 and 1970 were found in the 20% harvest ponds. Mortality of adult fish was usually low, with the exception of original stock bluegills in 1968. Many young-of-year bluegills were lost at time of fall draining because of aquatic vegetation in some ponds and because of physical stress from draining procedures. Harvest recommendations based on the results of this study and other observations are discussed.

GRAHAM, L. K. 1973$_a$. Fisheries management planning and research: The introduction of Florida largemouth bass in Missouri ponds. Dingell-Johnson Project MO F-1-R-22, Work Place 13, Job No. 2-I. Missouri Department of Conservation. Jefferson City, Missouri. 12 p.

GRAHAM, L. K. 1973$_b$. Optimum size and number of bluegills for stocking ponds. Dingell-Johnson MO F-1-R-22, Work Place 14, Job No. 2-I. Missouri Department of Conservation. Jefferson City, Missouri. 19 p.

GRANT, B. 1970. Florida bass invade California. Field and Stream 74(10) : 47, 130-131.

Despite the competition between Florida and California, the West Coast State has welcomed the bass invaders from Florida. The "invasion" began approximately ten years ago when Florida bass were transplanted into numerous lakes and reservoirs around San Diego. These bass are growing faster and larger than the "California" bass (northern largemouth bass) and are sought after by anglers.

The first water body to receive the Florida bass was Upper Otay Lake. The lake was chemically treated to remove all fish and then stocked with largemouths. The first attempt was a failure as all of the fish arrived heavily parasitized and very few survived the air transportation to the lake. The successful planting of 20,400 bass fry took place on May 7, 1959. This population grew rapidly and soon Upper Otay was being used as the source for all further Florida bass planting in California. Lakes Miramar, San Vincente, El Capitan, Murray and Morena as well as those to the north, such as Palomar and Escondido received Florida largemouth bass.

GREGG, B. and W. P. RUTLEDGE. 1990. Reservoir stocking history of Texas waters through December 1989. Management Data Series 27. Texas Parks and Wildlife Department. Austin, Texas. 54 p.

GRIFFITHS, F. P. 1939. Considerations of the introduction and distribution of exotic fishes in Oregon. Transactions of the American Fisheries Society 69(June) : 240-243.

Many introductions of exotic species have been made without considering the possible effects on native fishes. Nineteen of the eighty freshwater fish species in Oregon have been established by introduction. Introduced species include members of the Salmonidae (trout and salmon), Goregonidae (whitefishes), Percidae, Ameiuridae (catfishes), Moronidae (white basses) and Centrarchidae (the basses and sunfishes).

Both smallmouth and largemouth bass have been introduced into Oregon, although the largemouth is of much greater importance as a sportfish. The introduction of bass, perch and crappies is suspected as the force behind the decrease in trout. It is believed that the channel catfish and the smallmouth black bass are serious food competitors and as such their spread throughout the state is being carefully monitored, in contrast to earlier introductions.

GRIMALDI, E. 1972. Lago Maggiore: Effects of exploitation and introductions on the salmonid community. Journal of the Fisheries Research Board of Canada 29(6) : 777-785.

The lake trout (*Salmo trutta*) is the only salmonid which is native to Lago Magiore in northern Italy. Numerous species including coregines and char have been introduced over the years. Between 1880 and 1920, both the largemouth black bass (*Micropterus salmoides*) and pumpkinseed (*Lepomis gibbosus*) became acclimatized. The since-established population of largemouth bass is distributed throughout the lake, although its locations are concentrated and "spotty." The bass tend to remain in the areas of shore, which are lined with reeds.

GUEST, W. C. 1985. Statewide fisheries research: Texas statewide smallmouth bass fishery management. Dingell-Johnson Project F-31-R-11, Job No. LIV, Final Report. Texas Parks and Wildlife Department. Austin, Texas. 26 p.

GUY, C. S. 1990. Population dynamics of largemouth bass and panfish in South Dakota ponds. M. Sc. Thesis, South Dakota University. Brookings, South Dakota. 85 p.

Spring electrofishing samples were collected from 13 small impoundments in 1988 to determine relationships between largemouth bass and bluegills in South Dakota. In 1989, eight small South Dakota impoundments were sampled to evaluate relationships between largemouth bass and yellow perch.

HALL, C. R. 1977. An evaluation of Florida largemouth bass (*Micropterus salmoides floridanus*) introductions into a Texas power plant cooling reservoir. M. Sc. Thesis, Texas A&M University. College Station, Texas. 84 p.

HALL, J. F. 1958. Final report on the success of largemouth bass-bluegill and largemouth bass-shellcracker rates and ratios in Kentucky farm ponds. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 12 : 91-116.

In order to test the relative success of various stocking rates of largemouth bass (*Micropterus salmoides*) – bluegill (*Lepomis macrochirus*) combinations and largemouth bass – shellcracker (*Lepomis microlophus*) in farm ponds in Kentucky, 574 ponds were stocked with these fishes in the following combinations and rates: fry bass:fingerling bluegill 30:400, 50:500, 80:500 and 100:500 per acre; fry bass:adult bluegill 100:30, 100:50 and 100:70 per acre; fry bass: fingerling shellcracker 50:300 and 50:600 per acre, fry bass:fingerling shellcracker + mosquito fish (*Gambusia affinis*) 50:300 + 400 and 50:600 + 400 per acre.

In each year from 1952 through 1956 a series of ponds was stocked. No pond was stocked more than once nor with more than one rate. Bass-bluegill combinations were stocked in each of the first four years, the shellcracker combinations in 1953, 1955 and 1956. Each pond was investigated annually and the success of each rate was determined by the percentage of balanced ponds that the rate produced.

No significant differences in percentage of success were found among the following bass-bluegill rates: 80:500, 100:500 (fry bass:fingerling bluegill), 100:30, 100:50 and 100:70 (fry bass:adult bluegill). The most successful bass-shellcracker rate could not be determined because of the large number of ponds that failed to produce reliable data. A total of 384 or 66.9% of the ponds stocked failed to yield reliable data and were discontinued during the investigation. The invasion of the ponds by other fish was the principal reason that these ponds were discontinued.

HALL, T. J., S. P. GRAHAM and R. L. MILLER. 1985. Evaluation of yearling largemouth bass stocking in Delaware Lake, Ohio. Dingell-Johnson Project F-29-R-23 and F-29-R-24, Study 18. Ohio Department of Natural Resources, Division of Wildlife. Columbus, Ohio. 41 p.

HANSEN, D. F. 1966. Stocking and sport fishing at Lake Glendale (Illinois). Illinois Natural History Bulletin 29(2) : 105-156.

HARDERS, F. R. 1974. The dynamics of two Alabama farm pond fish populations resulting from stocking fingerling largemouth bass (*Micropterus salmoides*) and adult bluegill (*Lepomis macrochirus*). M. Sc. Thesis, Auburn University. Auburn, Alabama. 55 p.

HARDERS, F. R. and W. D. DAVIES. 1973. Variation in growth of bluegill attributed to differential stocking rates of adult fish in largemouth bass-bluegill combinations. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 27 : 777-782.

The growth of bluegill is compared from four Alabama farm ponds where two ponds were stocked with adult bass and bluegill and two were stocked with bass and fingerling bluegill. Results from fishing records show that the stocking rate of adult bass plus fingerling bluegill produces larger than average bluegill the first year after stocking.

HARDESTY, J. M. 1994. Results of transplanting advanced size largemouth bass (*Micropterus salmoides*) into El Dorado reservoir. M. Sc. Thesis, Emporia State University. Emporia, Kansas.

HARPER, J. L. 1984. Evaluation of supplemental stocking of Florida and northern largemouth bass as a management procedure in small impoundments. Oklahoma Department of Wildlife Conservation. Oklahoma City, Oklahoma. 39 p.

HARRELL, S. L. and E. D. DIBBLE. 1997. Untitled. Presented at the 1997 Southern Division of the American Fisheries Society mid-year Meeting. San Antonio, Texas. (Abstract only)

Aquatic plant beds containing high species diversity provide a suite of spatially complex habitats important to the growth of juvenile centrarchids. Concern has arisen over large dense monospecific stands of exotic aquatic plants in littoral zones of lakes and reservoirs, and their impact on the growth of small fishes inhabiting these areas. We investigated the relationship between aquatic plant beds and individual fish growth by conducting a pond experiment. Juvenile bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*) were introduced into enclosures with two aquatic plant treatments that consisted of either a bed of an exotic monoculture, *Hydrilla verticillata*, or plant beds containing diverse natives, *Vallisneria americana*, *Heteranthera dubia*, *Potamogeton nodosus*, and *Najas guadalupensis*. Plant treatments were replicated 6 times in 10 m diameter enclosures constructed within the experimental pond. Plant complexity and prey availability were measured, and individual growth rates of fishes were determined by use of dorsal marks with different color combinations of influorescent elastomer dye. To determine seasonal variation in growth rate, pop-nets and strata-traps were used to obtain subsamples of fish in each treatment (monoculture n = 42 and diverse n = 38) midway into the experiment. After 6 months the pond was drained and all fish were collected, identified, and lengths (SL & TL; mm) and weights (g) measured. Even though plant complexity differed significantly ($P < 0.05$) between plant treatments, no significant difference ($P > 0.05$) was noted in individual growth rates of the fishes.

HARRISON, A. C. 1930. Progress report on the acclimatization of smallmouth bass and bluegills. Cape Piscatorial Society Circular 32 : 1-5.

HARRISON, A. C. 1953. The acclimatization of smallmouth bass. Piscator 27 : 83-96.

HART, L. G. 1978. Smith Mountain Reservoir research study. Dingell-Johnson Project VA F-30-R-4, Studies 1-4, Job Nos. 1&2, Final Reports. Virginia Commission of Game and Inland Fisheries. Richmond, Virginia. 132 p.

HASTINGS, C., M. BOWLING, D. JOHNSON and J. FACTORA. 1968. Evaluation of introductions of smallmouth bass into streams. Dingell-Johnson Federal Aid Project GA F-17-R, Job No. 3. Georgia Game and Fish Commissioners. Atlanta, Georgia.

HEARN, M. C. 1977. Post-stocking survival of largemouth bass reared in raceways on artificial diets. Progressive Fish Culturist 39(3) : 126-127.

Largemouth bass (*Micropterus salmoides*) that were raceway-reared to a length of 13 cm on Purina Trout Chow were introduced into two 0.04-ha ponds containing fathead minnows (*Pimephales promelas*), to determine post-stocking survival. For comparison, two 0.04-ha ponds were stocked with largemouth bass of similar size which had been pond-reared on fathead minnows. After 27 days, both groups of bass had gained weight, but a substantially larger percentage of the pellet-fed bass had survived. The results indicated that bass reared intensively in raceways and fed an artificial diet survive and grow well when transferred to ponds, if live food is available and there is no competition from larger predators.

HEARN, M. C. 1998. Production of 12-inch largemouth bass at the Minor E. Clark hatchery (Kentucky). Presented at the 1998 Southern Division of the American Fisheries Society mid-year Meeting. Lexington, Kentucky. (Abstract only)

Largemouth bass, exceeding eight inches in length, were requested for a four-year stocking study at Carr Fork Lake (Kentucky). The fish were primarily produced on a pellet diet and averaged 12 inches in length after a 17 to 23-month production period. Surplus forage fish were added to the ponds during the winter and increased the cost of production: Survival of the fish from < 2.0 to 12 inches was better than anticipated and exceeded 50% for three of the four years.

HEBDA, A. J., G. M. JONES and L. J. HINKS. 1990. Smallmouth bass in Nova Scotia, biology and options for management: Section 8 management options. p. 68-73 *In* Nova Scotia Department of Fisheries Economic Regional Development Agreement Report No. 24. Halifax, Nova Scotia.

The primary conditions for determining the success of stocking with smallmouth bass include habitat quality, adequacy of forage base, and the absence of other populations that could be adversely affected. The following is a list of requirements that should be met before stocking smallmouth bass in Nova Scotia:

- The lake must be large, at least greater than 40 hectares.
- The water must be over 6 to 10 m deep, preferably with thermal stratification.
- Vegetation should be sparse and the water should be relatively clear.
- Shoals of rocks and/or gravel should be present for spawning grounds.
- Conditions in the lake cannot be eutrophic, only mesotrophic or slightly oligotrophic.
- The growing season must be at longer than 95-100 days.
- The pH must be over 5.5. Waters which are too acidic for salmonids will not be suitable for smallmouth bass.
- The presence of salmonids is not important and it is preferable if there are none in the area. For example, smallmouth bass cannot be stocked with brook trout if the trout fishery hopes to remain open.

HEIDINGER, R. C. 1976_a. An indexed bibliography of the largemouth bass (*Micropterus salmoides*). Fisheries Research Laboratory and Department of Zoology, Southern Illinois University. Carbondale, Illinois. 84 p.

This listing is an attempt to compile all North American literature on the largemouth bass (*Micropterus salmoides*). One-hundred and twenty journals and abstracts have been systematically searched and there appear a few journals from outside North America which are included in citations, yet have not been searched systematically.

HEIDINGER, R. C. 1976_b. Bass stocking. p. 49-55 *In* Synopsis of Biological Data on the Largemouth Bass. FAO Fisheries Synopsis No. 115. Food and Agriculture Organization of the United Nations. Rome, Italy. 85 p.

Stocking combinations for small lakes currently recommended by 17 state agencies are summarized. The bass-bluegill combination has been most frequently used. Monospecific stockings of bass in Illinois ponds resulted in standing crops as high as or higher than bass stocked in combination with other species. Growth rate, however, was slower. Unless preceded by at least partial renovation, maintenance stocking of fry or fingerling largemouth bass has been ineffective in reducing overcrowded forage fish populations. Some forage species, such as fathead minnow, are eliminated after a few years when bass are present. Bass and channel catfish are often stocked together in small ponds. With 0.9 kg bass present in a pond, channel catfish approximately 19 cm in length must be stocked to avoid elimination of the catfish by the bass.

HEIDINGER, R. C. 1993. Stocking for sport fisheries enhancement. p. 375-401 *In* C. C. Kohler and W. A. Hubert [eds.]. Inland Fisheries Management in North America. American Fisheries Society. Bethesda, Maryland.

Fish are currently being raised for stocking in sport fisheries by federal and state agencies and by private fish culturists. Warmwater, coolwater and coldwater fish are being propagated to enhance fisheries. In 1995-1996, 33 states were stocking largemouth bass (*Micropterus salmoides*) at the rate of 124-247 fry and 12-494 fingerlings per acre. At the same time, only twenty states were stocking smallmouth bass (*M. dolomieu*) and then the number stocked typically depended upon the number available from the hatchery.

Over the past twelve to fourteen years, the number of warmwater species stocked by the states has decreased. In 1995 or 1996, the total number of largemouth bass stocked was over 21 million, while that of smallmouth bass was nearly 3 million (including 25,000 stocked by two Canadian provinces).

One of the most popular stocking combinations involves the largemouth bass, bluegills and channel catfish. These species together bring about superior angling conditions. Many factors do, however, influence the success of bass stocking. The Florida largemouth bass, for example, does not survive as well in northern climates as the northern strain. The smallmouth bass experiences satisfactory growth in warm water but will not recruit when placed with largemouths and sunfish in the southern states and in its southern range it recruits in streams.

HEIDINGER, R. C. and R. C. BROOKS. 2000. Relative contribution of minnow- and pellet-reared largemouth bass to year-class strength in Crab Orchard Lake, Illinois. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

Very little research concerning stocking pellet versus minnow-reared, advanced fingerling largemouth bass (*Micropterus salmoides*) into fertile lakes exists. This project determined the relative contribution of stocked, advanced fingerlings (105-170 mm) reared on fathead minnows (*Pimephales promelas*), pellet-fed, or a combined diet of pellets and minnows to natural year-class strength. The bass were stocked at seven locations in Crab Orchard Lake in August 1993-1996 and 1998. Stocked bass contributed 16.4% of the age-0 fish collected (n = 1,623) and 13.6% of 844 age-1 bass collected during spring. Relative survival (RS) at age-0 favored minnow-reared bass by 3.745 to one (n = 130) over pellet-reared bass. Bass fed the combined diet survived at 1.3541 to one over minnow-reared bass (n = 136), but RS was not statistically significant (z = 1.8407). RS of age-1, minnow-reared bass was 3.1435 time that of pellet-reared fish (n = 5) and was statistically significant (z = 4.1284). Relative survival of age-1 bass fed the combined diet was 1.5977 times that of minnow-reared bass (n = 60), but the difference was not statistically significant (z = 1.9100). Results indicate that largemouth bass fed a minnow diet at least a week prior to stocking will have a better chance for survival than those fed exclusively on pellets.

HENDERSON, C. and R. F. FOSTER. 1956. Studies of the smallmouth black bass (*Micropterus dolomieu*) in the Columbia River near Richland, Washington. Transactions of the American Fisheries Society 86 : 112-126.

Observations on smallmouth black bass (*Micropterus dolomieui*) of the Columbia River were possible because of a transplantation program undertaken by local sportsmen and because of studies made by the United States Public Health Service and the General Electric Company to evaluate effects of the radioactive effluent from the Hanford reactors. The bass transplanting project consisted of catching adult bass from four sloughs near the old townsite of Hanford within the restricted area and moving these fish to the lower Yakima River. The fish were measured, weighed, sexed, and marked, and scale samples were taken before they were released.

The average bass caught with sportfishing gear was 15.5 inches long and weighed 40 ounces. Females were larger and made up a greater portion of the catch than males. Age was from three to eleven years but seven and eight-year-old fish made up about half of the catch. Growth was rapid in spite of a short season and water temperatures below that considered optimum.

Some spawning occurred in sloughs as early as April, but was unsuccessful because of a subsequent drop in temperature. Fry hatched from eggs spawned in July and August when temperatures were from 60 to 75°F. Transplanted bass move about considerably, but a definite migratory pattern was not established. Some fish moved over forty miles and many returned to the place of initial capture.

Radioactive materials, which originated in the effluent of the reactors, were acquired by the bass through food chains. The principal isotope concentrated in the fish and other river animals was radiophosphorus. The level of radioactivity in the bass was greatest in September and least in April. No adverse effects on bass or food organisms, attributable to radioactive effluents, could be detected. The radioactive contamination of the bass was too low to constitute a hazard to persons who might eat them.

HENDERSON, J. P. 1970. Fish population analysis on bass/shad stocked ponds. Dingell-Johnson Project IN FW-11-R-1, Job No. 5-A. Indiana Department of Natural Resources. Indianapolis, Indiana. 6 p.

HENSHALL, J. A. 1883. On the distribution of the black bass. Transactions of the American Fisheries Society 12 : 21-27.

At present the habitat of the black bass has been extended by transportation, and by means of artificial canals, so that it may be said to inhabit every State of the Union. It has also been successfully introduced into England, Scotland and Germany, thus occupying a wider range than any fresh-water fish in the world.

The black bass adapts easily to its new waters and quickly propagates when it is transplanted. It appears to be unaffected by climate, water type or geological formations. However, the smallmouth bass seems to restrict itself to older formations, while the largemouth bass moves freely through areas of stratified rock and has reached all the way to Florida.

As opposed to the arguments that black bass introduced into eastern waters have depressed the shad and salmon populations I dispute that there is no proof that these declines are caused by black bass. In Western waters, if any species suffers negative effects caused by the introduction of the black bass, it is the bass themselves, on account of overfishing.

HENSHALL, J. A. 1917. Stocking waters. p. 111-121 *In* Book of the Black Bass. Stewart and Kidd Company. Cincinnati, Ohio.

Although the success of black bass introductions has overshadowed that of many other species, it is not without its failures. Bass survive in polluted streams and waters blocked by dams yet cannot establish themselves in waters formerly inhabited by salmon species or brook trout.

Bass are near to impossible to spawn artificially and thus transplanting adults from one body of water to another is a worthwhile option. Because black bass practice a larger degree of parental care with their young, the offspring are protected from predators. It is almost guaranteed that a suitable lake or stream stocked one year with bass, that are at minimum one year of age, will quickly increase its bass population.

It is imperative that water conditions be suitable for stocking the bass. Any pond less than 3 acres in surface area will likely be a failure. New or renovated ponds should be stocked at least one year in advance to the stocking of bass, with appropriate food such as minnows, crustacea and frogs. The ponds must also be at minimum twelve feet in depth so that the bass may overwinter. Largemouth bass are best suited to large ponds or shallow lakes with little current and a muddy bottom. Smallmouth bass, in contrast, prefer running water and may be successful in streams.

The transportation of the black bass to their stocking site is typically done via the railway. A regular washtub can safely transport, for a long distance, twenty-five bass 6 inches in length. The larger the fish, the deeper the tub must be. The aeration of the transport water remains a problem if transportation is not occurring in an especially equipped railroad car. Frequent changing of the water is not an option as the change in temperature and character will be more detrimental to the fish than slightly dirty water. From stocking activities there is evidence that bass can be transported considerable distances with minimal mortalities. For example, six hundred and sixty bass were in transit for thirty hours with a loss of only sixty fish. The remaining 600 thrived in the newly stocked lake and multiplied rapidly.

There is no evidence to suggest that the introduction of black bass will have detrimental effects on native populations. As predators they prefer crawfish, minnows and insects to other fish. In some Wisconsin lakes the black bass currently co-exists with the cisco and there are numerous lakes in Canada which host healthy populations of brook trout and largemouth black bass.

HICKLEY, P., R. NORTH, S. M. MUCHIRI and D. M. HARPER. 1994. The diet of largemouth bass (*Micropterus salmoides*) in Lake Naivasha, Kenya. Journal of Fish Biology 44(4) : 607-619.

Lake Naivasha is a freshwater lake situated in the eastern rift valley of Kenya. Only five species of fish are present, all of which have been introduced. Of these, *Oreochromis leucostictus*, *Talapia zillii* and *Micropterus salmoides* (largemouth black bass) support an important gillnet fishery with bass also being taken for sport. Until bass reached 260 mm full length they depended upon invertebrates food organisms. Thereafter crayfish, fish and frogs became increasingly important the larger the size of the bass. The most important invertebrate prey species was the water boatman (*Micronecta scutellaris*) followed by chironomid and culicid pupae. Zooplankton was consumed but only in large quantity by fish smaller than 80 mm. For bass over 260 mm the crayfish (*Procambarus clarkii*) was the principal food. The largemouth bass in Lake Naivasha are generalized macro-predators, feeding principally on free-living animals of a kind most likely to be found in the littoral zone.

HILL, K. 1979$_a$. Evaluation of the split stocking method in Iowa farm ponds: Alternation of the split-stocking method. Dingell-Johnson Project F-90-R-2, Study No. 403.4, Job No. 1. Iowa Conservation Commission. Des Moines, Iowa. 15 p.

The goal of the split-stocking method is to recover the missing year class which often appears the year after the initial stocking. The objective of this study is to alter the farm pond stocking density which will allow reproduction of largemouth bass in the second year of life by stocking 70 bass/surface acre and continue to monitor two experimental ponds stocked at 100 bass/surface acre to determine the age of bass at maturity. The objective of this part of the study (Job No. 1) is to develop a farm pond stocking strategy that will provide for two consecutive year classes of largemouth bass by reducing the initial stocking density to 70 bass/surface acre.

Results for Job No. 1 showed mean estimated annual mortality of age II bluegill, age-I bluegill, and age-I largemouth bass as 55.2%, 61.4% and 45.4%, respectively. Age-0 bluegill mean mortality was 68.2% from seine haul and 73.6% from tow net data. Age-0 bluegill experienced higher mortality in ponds where age-I largemouth bass reproduced. Fecundity data shows age-I largemouth bass produced mature ova in four study ponds, but extreme mortality of age-0 bass resulted in complete year-class failure in one of the four ponds. Electrofishing catch indicated age-I largemouth bass successfully established a successive year class in 60% of the study ponds.

HILL, K. 1979$_b$. Evaluation of the split stocking method in Iowa farm ponds: Long term development of the split-stocking schedule. Dingell-Johnson Project F-90-R-2, Study No. 403.4, Job No. 2. Iowa Conservation Commission. Des Moines, Iowa. 7 p.

The objective of Job No. 2, of this study was to monitor the fish populations in two experimental ponds split season stocked with 1,000 fingerling bluegill, 100 fingerling channel catfish and 100 fingerling bass/surface acre and determine the long-term effects of this schedule on relative abundance, size structure of bluegill and largemouth bass and fecundity and age of maturity of largemouth bass.

Proportional stock densities (PSD) of largemouth bass in two study ponds were 62 and 40 while bluegill PSD values were 28 and 17. Electroshocking catch rates of bass and bluegill were highest in June and July and decreased through the sampling season. Seine haul catch rates were similar in both ponds. Bluegill catch rate peaked in August, but bass catch rates peaked in May and declined through the sampling season.

HILL, K. 1999. Putting "stock" in Iowa farm ponds. Iowa Conservationist May/June 1999 : 53-54.

Iowa farm ponds can be stocked, at no charge to the owner, by the Department of Natural Resources fisheries bureau if it meets certain requirements:

- The pond is free of fish.
- The surface area measures at least one-half acre.
- The maximum depth is eight feet.
- There is a fence to exclude livestock at least sixty feet from the edge of the pond.

If the pond meets these criteria it will be stocked with 750 to 1,000 bluegill fingerlings, 100 2-inch channel catfish fingerlings and 70 1.5-inch largemouth bass per acre. Bluegills and catfish are stocked in October and bass the following June. The reasoning behind the timing is that the largemouth bass will be able to dine on the newly hatched bluegill fry. It is expected that largemouth bass will have a fifty percent mortality rate during the first year of stocking and bass do not reproduce during their first year at densities less than 35 per acre, hence the stocking number. It is expected that if 100 8-inch channel catfish are planted every three years and largemouth bass fishing is regulated, the pond can provide fishing for decades.

HILL, T. K. 1967. Management techniques for public fishing waters: Some effects of a sanctuary on an exploited bass-sunfish population. Dingell-Johnson Project AL F-10-R-11/SP2. Alabama Division of Game and Fish. Auburn, Alabama. 22 p.

HOEY, J. W. and L. C. REDMOND. 1972. Evaluation of opening Binder Lake with a length limit for bass. p. 100-105 *In* J. L. Funk [ed.]. Symposium on Overharvest and Management of Largemouth Bass in Small Impoundments. American Fisheries Society Special Publication No. 3. Bethesda, Maryland.

This 150-A lake was stocked with several forage fishes and a reduced number of bass fingerlings. Adult bass spawned in the lake providing an additional size group of bass. This stocking manipulation provided fast growth and a wide size range of bass so that an effective size limit could be established on the bass to reduce initial harvest yet provide for bass to continually reach "legal" size.

The lake was opened to fishing September 21, 1968 with a minimum length limit of 14 in for bass. A quantitative daytime creel census was conducted through October, 1968 and April through October 15, 1969. By the end of October, 1968, 20 lb/A of bass had been removed at a fishing pressure of 63 h/A. In 1969, at a fishing pressure of 500 h/A, fishermen removed 61 lb/A of legal-sized bass. Over 19,000 bass were caught and released, providing additional fishing thrills. Rate of catch in 1969 (with released bass) was 2.65 fish/trip.

A second creel census was conducted May 1 through October 31, 1973. Fishermen caught fish at a rate of 5.7 fish/trip and applied a fishing pressure of 280 h/A. Bluegills dominated the catch, comprising 85% of the total number of fish harvested. An estimated 10 bass 14 in and over were harvested per acre. Only 11% of the bass caught were creeled. Growth of fish continues to be good, although some buildup of bass under 14 in is occurring. The structure of the bass population is better than in lakes without a length limit. There is a good size distribution of bluegills. Bluegills average about 6.5 in in three years; bass now appear to be entering the creel in their fourth and fifth year of life.

HOLCOMB, D. E. 1967$_a$. A study of stocking ratios of freshwater fishes. Dingell-Johnson Project FL F-14-R-7, Job No. 1, Final Report. Florida Game and Freshwater Fish Commission. Tallahassee, Florida. 25 p.

HOLCOMB, D. E. 1967$_b$. Experiment in rearing four to six inch largemouth bass for biological control. Dingell-Johnson Project FL F-14-R-7, Job No. H. Florida Game and Fresh Water Fish Commission. Tallahassee, Florida. 16 p.

HOLLOWAY, A. D. 1951. An evaluation of fish pond stocking policy and success in the Southeastern states. Progressive fish Culturist 13(4) : 171-180.

During the last four summers an attempt has been made to examine a sufficiently large number of farm ponds to obtain a picture of the success of the farm-pond management program. The stocking policy of the United States Fish and Wildlife Service for new farm ponds is to plant 50 bass (*Micropterus salmoides*) and 500 bluegills (*Lepomis macrochirus*) per acre in unfertilized waters and twice those numbers in fertilized waters.

An analysis of 323 randomly selected ponds showed that 7% were bass-heavy, 36% were in ideal balance (survival of bass and bluegills of all sizes, where intermediate bluegills are not abundant), 44% were static (many bluegills of intermediate size and adequate bass and bluegill reproduction occurs annually, yet much less than that found in ideal ponds), and 12% were considered out of balance (overrun with bluegills).

It is our belief that the proper balance of predators and nonpredators of desirable species is the factor that permits a satisfactory harvest by the hook-and-line method. Also, the stocking rate in relation to carrying capacity and the weeds that reduce predation are the two primary factors that permit or prevent the development and maintenance of a fish population in ideal balance.

Further, it is believed that the quantity of vegetation present plays an important role in the balance of a pond. It is recommended that 90% of the bottom of unfertilized ponds be free of vegetation. Unfertilized ponds of less than one acre and having a carrying capacity of less than 240 pounds per acre appear difficult to manage because of the small number of bass available to predation when stocked for the 1 to 3 weight ratio of bass to bluegills.

Carrying capacity and pond size are also a large problem. Small unfertilized ponds have few large bass and overcrowded bluegill populations by the third year following the initial stocking and fertilized ponds less than 0.3 acre in area experience similar difficulties.

The use of any uniform stocking rate in unfertilized ponds will produce disappointing results in many fishing ponds. As opposed to fertilized ponds, unfertilized water bodies do not appear to have the ability to modify their fish populations to achieve an ideal balance. Farm ponds which are fertilized have less range in their carrying capacity and can over time attain ideal balance if initial largemouth bass-bluegill stocking conditions were not appropriate.

HOOPER, G. R. 1970. Results of stocking largemouth bass, bluegill, and redear sunfish in ponds less than 0.25 acre. Proceedings of the Annual Conference of Southeastern Association of Game and Fish Commissioners 24 : 474-479.

A study was undertaken during the period of 1962-65 to determine the minimum acreage of water which can produce and sustain a balanced largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*) and redear sunfish (*Lepomis microlophus*) population. Thirty-three ponds ranging from 0.17 to 0.25 acres and which contained no fish were selected in North Alabama during 1962-63. The ponds were stocked by the State Fish Hatchery during the 1962-63 season. Suggestions that would aid in the management of a pond to obtain the maximum production of fish were offered to each pond owner.

Balance checks were conducted on these ponds during the first and second year of fishing. These checks on 30 usable ponds the first year indicated that 16 ponds contained a balanced fish population. Seven ponds contained a crowded bluegill population and seven ponds were crowded by competitive species. Checks on 29 usable ponds the second year indicated that 7 ponds contained a balanced fish population. Fourteen ponds contained a crowded bluegill population and 8 ponds were crowded by competitive species. The low percentage of ponds that maintained a balanced population indicated that it is not feasible to stock ponds that are smaller than 0.25 acres with a largemouth bass, bluegill and redear sunfish combination.

HOOVER, R. S. 1992. Assessment of the performance of stocked northern and Florida largemouth bass and their progeny in Briery Creek Lake, Virginia. M. Sc. Thesis, Virginia Polytechnic Institute and State University. Blacksburg, Virginia. 116 p.

HOOVER, R. S., J. J. NEY and E. M. HALLERMAN. 1991. Comparison of Florida and Northern subspecies of largemouth bass in Briery Creek Lake, Virginia. Virginia Journal of Science 42(2) : 215. (Abstract only)

HOXMEIER, J. H. and D. H. WAHL. 2000. Contribution of stocked largemouth bass in Midwestern reservoirs: Effects of natural recruitment, stocking size, and rearing techniques. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

Largemouth bass are often stocked in Midwestern reservoirs to compensate for poor natural recruitment, however, the contribution of these fish is often unknown. The success of stocked bass may depend on stocking size, rearing technique, or strength of natural recruitment. We stocked 17 reservoirs in Illinois with varying levels of natural largemouth bass recruitment with 100-mm largemouth bass in the summer of 1999. Size comparisons were conducted in 4 lakes by stocking 50, 100, 150, and 200-mm largemouth bass into each lake. A comparison of intensively (hatchery raceway) versus extensively (pond) reared bass was also completed in 4 lakes. Each lake was electrofished during the fall to assess the contribution of stocked largemouth bass across lakes, size groups, and rearing techniques. Contribution of 100-mm largemouth bass ranged from 0 to 62% across all reservoirs but was not dependent on existing age-0 year-class strength. Size at stocking affected contribution with bass stocked at larger sizes (150 or 200-mm) having higher CPUE than smaller sized (50 or 100-mm) bass. We did not detect a difference in stocking success between rearing techniques, however, comparisons were difficult because of low sample sizes. We recommend stocking larger sizes (150 mm) of largemouth bass reared either in raceways or ponds. Although natural recruitment did not affect stocking success, other lake characteristics may be important.

HOYT, R. D. 1974. The effect of stocking on the meristic complement of the Neosho smallmouth bass. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 27 : 643-652.

Neosho smallmouth bass were collected from 1962-64 in tributaries of the Arkansas River in northwest Arkansas and southern Missouri. Counts were made of dorsal spines and soft-rays, anal spines and soft rays, pectoral fin rays and lateral line scales. The data were compared with that for intergrade smallmouth from other drainages in Arkansas and with data given by Castro (1963) and others. Neosho smallmouth in this study had significantly higher mean counts than those reported in 1940. Each stream having higher counts had been stocked with the intergrade form of smallmouth bass from the White River in Arkansas.

HUGHES, J. S. and H. H. DOUGLAS. 1966. Movement of native and stocked fish in D'Arbonne Lake after impoundment. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 19 : 349-364.

A total of 3,174 native fish of 29 species was tagged and released in Bayou D'Arbonne during the spring and summer of 1963. The distance and direction of movement of captured fish were recorded before inundation and again after the flooding of the 1,500-acre impoundment, D'Arbonne Lake, in January 1964. Of the 57 tagged fish returned before inundation, 54 were recaptured in the same location. One fish moved upstream for a distance of 3.3 miles and two fish moved downstream for an average distance of 6.8 miles. After the lake was filled, the fish exhibited extensive movements and only 11% of the returns occurred in the release areas. Thirty-three of the 84 fish recaptured in the lake moved toward the headwaters while 35 fish moved toward the spillway. A total of 4.4% of the native fish tagged were recovered. Tagged hatchery-reared bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), channel catfish (*Ictalurus punctatus*), and black crappie (*Pomoxis nigromaculatus*) numbering 9,173 individuals were stocked in D'Abonne Lake. The direction and distance of movement of these fish were also recorded. Sixty-one hatchery-reared fish (0.7%) were recovered from the lake. Largemouth bass showed an upstream movement while 50 to 54% of the bluegill and channel catfish showed no movement. No tagged black crappie were recovered. A determination of the number of fish release sites necessary for stocking large impoundments was a primary objective.

HUNT, J. and C. ANNETT. 1994. Success of supplemental stocking of largemouth bass in Arkansas reservoirs: Effects of season and reservoir type. American Fisheries Society Annual Meeting 124 : 180. (Abstract only)

Young-of-the-year largemouth bass were marked via freezebranding and stocked supplementally into four small (100-350 acres) impoundments during 1991, 1992 and 1993 to assess relative survival of spring- and fall-stocked fingerlings. Stocked and naturally spawned fingerlings were captured via seining, rotenone sampling, and electrofishing to compare size distribution and contribution to year-class strength of each. Survival rates of stocked fingerlings varied among reservoirs, season of stocking, and year of stocking, but levee reservoirs generally experienced higher survival than impoundment reservoirs. Variability of survival rate was high among lakes within the same stocking season (up to an 18-fold difference), but was lower between years for the same lake (only 2-3 fold differences). Survival rate of fall fingerlings was 3-4 times higher than spring fingerlings. Size distribution of stocked fingerlings was consistently higher than that of naturally-spawned YOY.

ILLINOIS DEPARTMENT OF NATURAL RESOURCES. 1998. Fish stocking policy. Illinois Department of Natural Resources. Springfield, Illinois. 8 p.

In Illinois there exists separate policies for stocking public and non-public waters. Largemouth bass are generally preferred to smallmouth bass when stocking non-public areas. For largemouth bass new or rehabilitated organizational and private lakes are stocked initially with 50-100 fish per surface acre. Smallmouth bass, on the other hand, are only stocked when the area fisheries manager determines that they are more desirable than largemouth bass. The stocking only occurs in new or rehabilitated lakes at a rate of 50-100 fingerlings per surface acre. Supplemental stocking is not permitted on non-public waters and all fish will be stocked in June and July.

Both supplemental and introductory stocking occurs on public waters. State lakes have first priority, reservoirs second, and public lakes third. Fingerlings are generally stocked at 50-100 fish per acre, depending on the fertility of the water. Occasionally large fingerlings or yearlings are used to replace/supplement weak year classes. The stocking rates, according to fish size are: 2.0-2.9 inches, 75-100 fish/acre; 3.0-3.4, 60/acre; 3.5-3.9, 40/acre; 4.0-4.9, 20/acre; and fish greater than 5 inches are stocked at a rate of 10/acre. The stocking practices of smallmouth bass in public waters, generally follow those of the largemouth bass, with the exception of streams having secondary stocking priority. It is not recommended that smallmouth bass be planted with populations of largemouth bass, green sunfish or bluegills.

INKO-TARIAH, M. B. 1976. Production of *Tilapia aurea* in polyculture: Using largemouth bass or monosex stocking for population control. M. Sc. Thesis, Auburn University. Auburn, Alabama. 27 p.

INMAN, C. R., R. C. DEWEY and P. P. DUROCHER. 1977. Growth comparisons and catchability of three largemouth bass strains. Fisheries 2(5) : 20-25.

Florida largemouth bass (*Micropterus salmoides floridanus*), northern largemouth bass (*M. s. salmoides*), and their F_1 hybrid were stocked in a 3.64-ha pond, and their growth rates and catchability compared. The hybrid and Florida bass were found to achieve the best growth over a 3-year period, apparently because of genetic influences rather than environmental factors. Differences in catchability were not observed among the three strains of largemouth bass.

ISELY, J. J., R. L. NOBLE, J. B. KOPPLEMAN and D. P. PHILIPP. 1987. Spawning period and first-year growth of northern, Florida, and intergrade stocks of largemouth bass. Transactions of the American Fisheries Society 116(5) : 757-762.

Subspecific differences in spawning period and first-year growth of largemouth bass (*Micropterus salmoides*) were investigated by examination of otoliths from experimental populations established in research ponds in Illinois. Compared with Florida largemouth bass (*M. s. floridanus*), northern largemouth bass (*M. s. salmoides*) were spawned earlier and grew larger (total length, weight) during the first growing season. Intergrade fish exhibited characteristics of age and growth intermediate between those of the two pure parental subspecies. The observed differences in size were independent of age, indicating that first-year differences in size were enhanced by genetic differences affecting growth rate. Peak production of F_1 intergrades occurred during the overlap in the northern and Florida largemouth bass spawning periods. However, F_1 intergrades were produced throughout the overall period of largemouth bass spawning.

JACKSON, J. R., R. L. NOBLE and J. R. COPELAND. 2000. Behavior, growth, and survival of individually-marked fingerling largemouth bass stocked into a North Carolina reservoir. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

We used individually coded wire tags to evaluate behavior, growth and survival of hatchery-reared largemouth bass (*Micropterus salmoides*) relative to wild-hatched fish in a North Carolina reservoir. In June 1990 and 1991, we stocked 1,674 and 1,419 tagged hatchery fish, respectively, into an embayment where 1,090 and 1,133 native fish were also tagged. Recaptures were obtained by electrofishing every three weeks through October. Hatchery bass dispersed limited distances from stocking sites after release and afterwards exhibited fidelity to small ranges similar to native fish. Mean individual growth rates in 1990 were 0.18 mm/day for hatchery fish and 0.14 for native fish, and were not statistically different (P=0.30). In 1991, growth rate of stocked bass was 0.30 mm/day, and was significantly faster than that of native fish (0.20 mm/day, P=0.002). Recapture:capture ratios were stable through the growing season for both groups in both years, indicating that mortality and emigration did not differ between stocks. Instantaneous daily mortality rates, estimated by catch curves, were higher for native fish in 1990 (P=0.05), and did not differ between stocks in 1991 (P=0.12). Our results suggest that when stocked into appropriate habitats, hatchery-reared largemouth bass perform similarly to native bass and can contribute to year class strength.

JANISCH, J. L. 1976. Largemouth bass growth rates in rearing ponds stocked with adult forage fish. Progressive Fish Culturist 38 : 42-43.

The raising of largemouth bass (*Micropterus salmoides*) beyond the planktivorous stage requires large amounts of forage and generally is not considered feasible. The objective of this particular study was to evaluate the effects of stocking adult forage fish and the rearing of largemouth bass past the planktivorous stage.

In April 1972, 19,900 3-inch largemouth bass fingerlings were stocked in eight ponds (ranging in size from 0.62 to 1.40 acres) at densities ranging from 1,862 to 2,343 bass per acre. Two ponds were stocked weekly with fathead minnows and six were stocked with forage fish (four with bluegills, one with goldfish and one with gizzard shad). Fertilizer was applied to the ponds to stimulate zooplankton growth. Minnows were stocked weekly whereas forage fish were stocked once at the time of the initial largemouth bass stocking.

By February 1973, overall bass survival was 78.8%. Growth was best in Pond 1 (0.62 acres, 1983 bass per acre and minnow fed), poorest in Pond 5 (1.37 acres, 1980 bass per acre and minnow fed). Growth of bass in ponds containing forage fish was considered good, with the exception of a bluegill-stocked pond and that stocked with goldfish. Gizzard shad as forage gave similar bass growth rates as that provided by bluegills.

It is suspected that the difference in growth rates was likely due to the availability of forage. Overall, largemouth bass stocked with forage fish grew an average of 3.6-inches in the ten months they were in the pond.

JANNEY, E. C. and Dr. K. J. HARTMAN. 2000. Evaluation of largemouth bass stocking in two Ohio River embayments. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

The West Virginia Department of Natural Resources has come under public and political pressure to enhance the Ohio River bass fishery through the use of a supplemental stocking program. To determine the effectiveness of such a stocking program, 4,700 tagged largemouth bass (*Micropterus salmoides*) were stocked into two Ohio River embayment areas on October 20, 1998 at densities of 25 intermediate (6-8 inches) and 10 adult (10-12 inches) fish per surface acre. Post-stocking electrofishing surveys, creel census, and tag return data were used to monitor the survival, movements, growth analysis, and percent of stocked fish caught by anglers. To date, creel survey data show that 31 tagged bass have been caught during 675 angler hours. This represents 84% of the total largemouth bass catch in the vicinity of the study areas during the first two months after stocking but only 2.5% of the subsequent catch. Electrofishing data will be presented that show decreasing capture rates of stocked bass in relation to capture rates of wild bass over time. The results of this project may aid in determining the effectiveness of stocking programs as a management tool to enhance largemouth bass populations in large riverine systems.

JENKINS, R. M. and D. I. MORAIS. 1976. Prey-predator relations in the predator-stocking-evaluation reservoirs. Proceedings of the Southeastern Association of Game and Fish Commissioners 30 : 141-157.

The method advanced for estimating prey-predator relations in reservoirs is based on fish standing crop data derived from samples collected in rotenone-treated coves in 23 reservoirs. The sampling, in August 1972 and 1973, was part of a cooperative study conducted under the auspices of the Reservoir Committee, Southern Division of the American Fisheries Society. Estimates were made of sizes of prey species which predators with various mouth sizes could swallow; lengths of all species of predators were then adjusted to equal the lengths of largemouth bass of equivalent predatory capability; and a computer program was developed to calculate biomass of prey available to predators in length classes equivalent to 1-inch length classes of bass 1 to 28 inches long. Results indicated that 50% of the populations sampled were deficient in available prey. Stocking of additional predators in these instances would be deemed inadvisable.

JOHNSON, D. L. 1975. A comparison of Florida and northern largemouth bass in Missouri. Paper presented to the Faculty of the Graduate School University of Missouri. Columbia, Missouri. 111 p.

Florida largemouth bass (*Micropterus salmoides floridanus*) were compared to the northern subspecies (*M. s. salmoides*) in both cages and ponds. The subspecies were compared as to growth, food consumption, dominance, angling vulnerability, survivorship, length-weight relationship, and temperature tolerance.

Adults of the two subspecies were fed fathead minnows (*Pimephales promelas*) or goldfish (*Carassius auratus*) *ad libitum* in individual cages measuring 8 to 32 cubic feet. Lengths and weights of experimental fish were taken at [illegible] week intervals for two growing seasons. In 1972, northern bass had significantly higher mean total length and weight increments (40 mm and 139 g, 1.6 in and 0.48 lb) than Florida bass (16 mm and 78 g, 0.6 in and 0.17 lb). In 1973, there was no difference in length increments of northern (17 mm, 0.7 in) and Florida bass (12 mm, 0.5 in) although the northern bass had a significantly higher mean total weight gain and mean total consumption (139 g and 1058 g, 0.31 lb and 2.33 lb) than the Florida subspecies (78 g and 785 g, 0.17 lb and 1.73 lb). Pond-raised bass, which were similar in size to the caged fish, had mean length increments of 55 mm (2.2 in) for northern bass and 48 mm (1.9 in) for Florida bass. The mean weight increments of these pond fish were 442 g (0.97 lb) for the northern bass and 355 g (0.78 lb) for the Florida subspecies. These figures indicate a similar relationship between Florida and northern bass in the pond and cage experiments but with a three-fold increment in open water as opposed to cages in 1973 for northern bass and a greater than four-fold increase for the Florida bass. This means that confinement greatly reduced growth and that the reduction of growth in cages may be greater in Florida than northern bass

Both length and relative weight increments occurred in dichotomous seasonal patterns with maxima in early June and August and a reduction in growth in late June or July. This pattern may be related to water temperature or endogenous growth rhythms.

Hierarchy experiments with pairs of bass sharing compartments resulted in very poor growth for surviving fish and periodic mortality apparently related to interaction within the cage.

Length-weight formulae was calculated and analyzed through covariance. Regression lines of caged Florida bass and pond Florida bass were significantly different, reflecting different environments. No significant differences in length-weight regression lines were found for the two subspecies in the same environments.

In small ponds, mean annual survival of northern bass fingerlings was 65% (92-57%), Florida bass survival was 4% (8-0%). In laboratory tests of temperature tolerance at 4°C (39°F), survival of Florida bass was 0% and northern bass about 86%. In further laboratory tests, gradual cooling of 1°C (1.8°F) per day from 15°C (59°F) to 4°C (39°F) resulted in 0% survival of Florida bass and 85% survival of northern bass.

Florida bass tended to react to handling with more vigorous activity than northern bass; Florida bass exhibited a higher incidence of handling-related diseases.

The results of these studies indicate that the Florida largemouth bass offers no advantage and little promise for management in most Missouri ponds and reservoirs.

JOHNSON, D. L. and R. O. ANDERSON. 1974. A comparison of Florida and northern largemouth bass in Missouri. Midwest Fish and Wildlife Conference 36 : 82. (Abstract only)

JOHNSON, D. L. and L. K. GRAHAM. 1978. Growth, reproduction, and mortality factors affecting the management of largemouth and smallmouth bass. p. 92-103 *In* G. D. Novinger and J. G. Dillard [eds.]. New Approaches to the Management of Small Impoundments. American Fisheries Society, North Central Division, Special Publication 5. Bethesda, Maryland.

Comparative studies on largemouth bass and smallmouth bass revealed that the largemouth out-competes smallmouth when stocked together in farm ponds, often to the total extinction of the smallmouth. Gravel spawning substrate was necessary for smallmouth reproduction in ponds. Smallmouth may be more vulnerable than largemouth in controlled angling studies, especially in June and September.

Lake form smallmouth bass showed higher food consumption, feeding efficiencies, and growth in pounds than did stream forms. The lake form was much more vulnerable to angling than was the stream form.

Florida largemouth bass (*Micropterus salmoides floridanus*) were found to be highly excitable and generally less vulnerable to angling. Growth rates of young (age I to III) Florida and northern largemouth bass tended to be equal, or faster for the northern subspecies. Florida bass were intolerant of 39°F (4°C) temperatures in laboratory situations and had consistently higher winter mortality in Midwestern ponds.

JOHNSON, F. H. and J. G. HALE. 1977. Interrelations between walleye (*Stizostedion vitreum vitreum*) and smallmouth bass (*Micropterus dolomieui*) in four northeastern Minnesota lakes, 1948-1969. Journal of Fisheries Research Board of Canada 34 : 1626-1632.

Smallmouth bass (*Micropterus dolomieui*) introduced from 1945 to 1948 into four rocky, infertile northeastern Minnesota lakes with established walleye (*Stizostedion vitreum vitreum*) populations reached maximum abundance in 9-15 years and then declined to low numbers within 2-4 years. In three, walleyes declined as the bass increased and in the fourth there was a simultaneous increase of walleye and bass followed by increased abundance of walleye with the decline of bass. Interspecific competition for spawning sites, shoal habitat, or food did not appear to be factors in the fluctuations in abundance. Growth of both species was density-dependent implying that intraspecific competition may have been the main factor. Also, predation of young walleye by bass may have been a factor in failure of walleye year-classes.

JOHNSON$_a$, J. E. 1996. Five years of smallmouth bass production in Braver Reservoir nursery pond, Arkansas. Presented at the Arkansas Chapter of the American Fisheries Society 1997 Annual Meeting, February 15-16, 1996, Jonesboro, Arkansas. (Abstract only)

Arkansas Game and Fish Commission stocked smallmouth bass into Beaver Reservoir between 1981 and 1994 in an attempt to establish that game fish. Between 1988 and 1994, smallmouth bass were stocked using the newly constructed 11 ha Beaver Nursery Pond. Adult fish were captured from Bull Shoals Reservoir in April, allowed to spawn in the nursery pond, and young-of-year fish and their parents were then emptied into Beaver Reservoir. In 1990, Arkansas Coop Research Unit began estimating the number of young smallmouth bass produced in the Beaver Nursery Pond. During the first three years the nursery pond was released of fish in late June. Estimated numbers of young-of-year fish were: 1990 = 118,000 fish, 1991 = 165,000 fish, 1992 = 57,000 fish; mean total lengths during those releases were 52 mm, 45 mm, and 53 mm, respectively. In 1993, fish in the nursery pond were held until September 23. Numbers of young fish produced dropped by 50% from earlier years (62,000 fish) and nearly doubled in mean size (87 mm). Between 1990 and 1994 nearly 500,000 young smallmouth bass were stocked into Beaver Reservoir, along with approximately 2,000 adult fish. Success of the nursery pond stocking was first found in 1992 when 56 young-of-year smallmouth bass were captured in Beaver Reservoir prior to release of the nursery pond

JOHNSON, J. E., M. G. PARDEW and D. W. BOWMAN. 1993. Evaluation of nursery pond stocks and resultant dispersal and survival of released fish: A final report on smallmouth bass in Beaver Reservoir. Dingell-Johnson Project AR F-54-R-1, Final Report. Arkansas Game and Fish Commission. Little Rock, Arkansas. 180 p.

Objectives were to evaluate methods of estimating numbers of fish produced in nursery ponds, and to estimate survival and dispersal of fish after being stocked into reservoirs. Seven methods of estimating numbers of young fish were tested: fecundity of adult fish, number of occupied nests, SCUBA transects, minnow traps, shore seining of known areas, mark and recapture, and effluent collection.

JOHNSON, J. E., M. G. PARDEW and D. W. BOWMAN. 1996. Use of a nursery pond to establish smallmouth bass in Beaver Reservoir, Arkansas. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 50 : 122-130.

Production of smallmouth bass in 11-ha Beaver Nursery Pond was estimated from 1990 to 1994 to determine numbers of fish stocked in Beaver Reservoir. In 1990, two rapid population sampling methods, seining a known area and SCUBA transects, were tested against a Petersen mark-and-recapture estimate.

JOHNSON, M. G. and H. R. MacCRIMMON. 1967. Survival, growth and reproduction of largemouth bass in southern Ontario ponds. Progressive Fish Culturist 29(4) : 216-221.

Several combinations of largemouth bass and forage fish have been recommended for the stocking of warmwater ponds in various parts of the United States. Several of these combinations were examined in one experiment to guide management of largemouth bass in southern Ontario ponds. Late in the summer of 1959, largemouth bass were introduced into 10 study ponds at the rate of 100 fingerlings per surface acre. Average total length of the bass was 2.3 inches. Late in November 1959, two of these ponds were stocked with adult golden shiners (200 per acre) and two ponds with fathead minnows (300 per acre). Early in May 1960, adult bluegills (25 per acre) were added to the bass populations in another two ponds. In two of the remaining four ponds, the largemouth bass was the only fish species stocked. In the other two, the bass were added to established populations of coarse fish. In 1960, a second set of 10 ponds involving 2 ponds per combination was added to the study. All stocking times and rates were the same as those used the previous year. The average total length of fingerling bass was 3.9 inches.

Of the bass stocked in 1959, 55% survived to age 1 and 42% survived to age 2; whereas 66% of the bass stocked in 1960 survived to age 1. The survival rates of bass differed widely but only bass that were stocked with coarse fish showed significantly low survival. The loss of bass from study ponds during early spring overflows should be considered as a factor that may have influenced bass survival estimates.
The bass stocked in 1959 attained an average length of 9.1 inches and weight of 0.43 pound by October 1960. By October 1961, they averaged 11.1 inches and 0.84 pounds. Bass stocked in 1960 had an average length of 8.9 inches and weight of 0.43 pounds in October 1961. Growth rates in the stocking combinations were markedly different. Bass with bluegills and coarse fish had the greatest growth rates, bass with golden shiners made the least gain, and bass with fathead minnows and bass alone showed intermediate growth in both experimental lots of ponds. Stocking a pond with bluegills produces good growth in bass, particularly when adult bluegills are stocked with the bass. Whether to stock the bass alone or with bluegills probably would depend on the added value of the bluegill population to the fishery and the intensity of management planned for the bass bluegill population.

JOHNSON$_b$, R. L. 1996. Comparison of growth, relative weight and health of largemouth bass in two Arkansas lakes. Presented at the Arkansas Chapter of the American Fisheries Society 1997 Annual Meeting, February 15-16, 1996, Jonesboro, Arkansas. (Abstract only)

Lakes Ashbaugh and Swepco are both located in northern Arkansas, yet at opposite ends of the state. Swepco Lake is unique among Arkansas reservoirs in that it receives thermal affluent from an electrical power station. Swepco Lake was intentionally stocked with Florida largemouth bass (*Micropterus salmoides floridanus*) (FLMB) a single time in 1980; Lake Ashbaugh was unintentionally stocked with FLMB alleles due to mixed broodstock within the state fisheries division. Both lakes have been identified as possessing high frequencies of Florida bass alleles. Largemouth bass were collected from Lake Ashbaugh (n = 152) and Swepco Lake (n = 53) with assistance from the Arkansas Game and Fish Commission. Length at age, relative weight, phenotype and health were determined for both populations. Length at age, total weight and length, absolute weight and relative weight were significantly greater for Swepco Lake largemouth bass than for Lake Ashbaugh bass ($P > 0.001$). An autopsy-based fish health assessment revealed that Swepco bass also had greater health. Largemouth bass of Lake Ashbaugh were characterized by a heavy parasite load; Swepco Lake bass exhibited high deposition of mesenteric fat. Largemouth bass of both lakes exhibited high allele frequencies for the Florida subspecies, with the ratios largely reversed for each lake. There was a dominance of intergrade bass within both lakes. Despite these mixed alleles, there was no significant differences identified for bass possessing or lacking Florida alleles for any of the parameters measured within each lake.

JOHNSON, R. L. 1997. Comparison of growth, relative weight and health of largemouth bass in two Arkansas lakes. Presented at the Arkansas Chapter of the American Fisheries Society 1997 Annual Meeting, February 25-27, 1997, Bull Shoals, Arkansas. (Abstract only)

Lakes Ashbaugh and SWEPCO are both located in northern Arkansas, yet at opposite ends of the state. SWEPCO Lake is unique among Arkansas reservoirs in that it receives thermal affluent from an electrical power station. SWEPCO Lake was intentionally stocked with Florida largemouth bass a single time in 1980; Lake Ashbaugh was initially stocked with 50,000 Florida largemouth bass followed by successive stockings of 76,000 northern largemouth bass over the next decade. Both reservoirs have previously been identified as possessing Florida bass alleles. Bass were collected from Lake Ashbaugh (n = 436) and SWEPCO Lake (n = 141) for the years 1995-1996. Growth, relative weight, phenotype and health were determined for both populations. Length-at-age and relative weight were significantly greater for SWEPCO Lake bass than for Lake Ashbaugh bass. Allele frequencies of three discriminant allozyme loci, AAT-B, IDH-B and MDH-B, between Florida and northern largemouth bass were determined. Over half (62%) of the largemouth bass of Lake Ashbaugh and 98% of SWEPCO bass possessed Florida largemouth bass alleles, with F_1 bass dominant. No significant differences were identified for back-calculated length-at-age between the phenotypes of the northern largemouth bass, F_1 and F_2 intergrades for Lake Ashbaugh, while both F_1 and Florida largemouth bass exhibited significantly greater lengths-at-age than did northern largemouth bass for age I and II bass. No phenotypic differences were observed for relative weight and condition for either reservoir. An autopsy-based fish health assessment revealed that SWEPCO bass also had greater health. No significant differences were identified for bass possessing or lacking Florida alleles for any of the health parameters measured within each lake.

JONES, T. A., D. FLETCHER and M. PALLER. 2000. Movement of largemouth bass in a Savannah River tributary. Presented at the Southern Division of the American Fisheries Society mid-year Meeting, February 3-6, 2000, Savannah, Georgia. (Abstract only)

Movements of largemouth bass in Steel Creek, a Savannah River tributary, and between Steel Creek and the Savannah River were evaluated with radio telemetry. Thirty largemouth bass (> 250 mm) were implanted with radio transmitters and released either at the headwater of Steel Creek, near the mouth of Steel Creek or in the Savannah River near Steel Creek in the spring of 1999. Fish locations were determined biweekly, and temperature, oxygen and discharge were monitored throughout the study. In addition to biweekly locations, a subset (10) of fish were located hourly for 24 hours once in summer and once in fall. Largemouth bass in Steel Creek have relatively small (< 200 m) well defined home ranges. Individual home ranges tend to overlap within Steel Creek. Some large-scale (> 1 km) movements were observed and were loosely correlated with discharge. Preliminary results suggest that movement of largemouth bass between Steel Creek and the Savannah River are limited during summer and fall.

JORGENSEN, C. Undated. The tagging and transfer of fish from Vermillion Lake to Lake Temagami. File Report. Ontario Department of Lands and Forests. Temagami, Ontario.

Vermilion Lake is in the process of being drained by the Sherman Mine Company. The purpose of this operation was to catch the sport fish in Vermilion Lake and transfer them to Lake Temagami. Tagging of the Vermilion Lake fish was done to distinguish them from Lake Temagami populations. Smallmouth bass were included in this transfer along with pike, suckers, rock bass, sunfish and yellow perch.

One hundred and twenty-six pike and 77 smallmouth bass from Vermilon Lake were tagged and successfully transferred to Lake Temagami. A few of these have already been caught by anglers. The flesh of one recovered bass was found to contain numerous black spots the size of pinheads. The pike and suckers possessed the highest populations.

The bass had a dominating class whose members had a total length of approximately 9 inches.

JUBB, R. A. 1973. Notes on exotic fishes introduced into South African inland waters. Piscator 87 : 9-12.

JUNOR, F. 1980. Stocking Lake Kyle with largemouth bass. The Fishing Journal 1(1) : 26-28.

KAFFKA, J. 1978. A new bass for Arkansas. Arkansas Game and Fish 10(1) : 2-5.

KAUFFMAN, M. L. 1977. The growth and ecology of stocked largemouth bass (*Micropterus salmoides*) in Kahle Lake, Clarion-Venango Counties, Pennsylvania, including a comparison of collecting techniques. M. Sc. Thesis, Clarion State College. Clarion, Pennsylvania. 117 p.

KEMPINGER, J. J. and J. W. MORSELL. 1969. Statewide fishery research: Development and yield to the angler of a re-introduced smallmouth bass-yellow perch population in Nebish Lake. Wisconsin Conservation Department. Madison, Wisconsin. 14 p.

KEMPINGER, J. J., A. M. FORBES, S. L. SERNS and H. E. SNOW. 1982. Population development of re-introduced smallmouth bass and yellow perch in Nebish Lake.

Research Report No. 119. Wisconsin Department of Natural Resources. Madison, Wisconsin. 20 p.

KERR, S. J. 1978. Biological feasibility of a smallmouth bass, *Micropterus dolomieui*, introduction to Murray Lake. Ontario Ministry of Natural Resources. 14 p.

From the limited physical-chemical data and information available at this time, it would appear that Murray Lake could support a resident smallmouth bass population.Turbidity and temperature, often limiting factors for smallmouth bass, would not seem restrictive in Murray Lake. The availability of spawning shoals would also appear favourable for a resident smallmouth bass population. Little, if any, competition between yellow pickerel and smallmouth bass can be expected. Differences in habitat selection, preferred spawning areas, and feeding habits would tend to indicate that both species could co-exist in Murray Lake. Other considerations such as the availability of fish and actual operational feasibility must also be considered prior to the actual introduction of smallmouth bass to Murray Lake.

KERR, S. J. 1999. Mississippi Lake and its fishery. Southcentral Sciences Section Technical Report TR-115. Ontario Ministry of Natural Resources. Kemptville, Ontario. 36 p. + appendices.

It is believed that largemouth bass were introduced sometime in the early 1900s. This introduction proved to be successful and no further plantings were needed. Smallmouth bass were stocked regularly between 1916 and 1971 with fry, fingerlings and adults.

KERR, S. J. and R. E. GRANT. 2000$_a$. Largemouth bass – Potential interactions and impacts. p. 307-308 *In* Ecological Impacts of Fish Introductions: Evaluating the Risk. Ontario Ministry of Natural Resources. Peterborough, Ontario. 473 p.

The introduction of largemouth bass can have a detrimental impact on the native inhabitants of a lake. They are known to prey upon esocids and are especially lethal when planted as small fish during the summer. Largemouth bass predation has in extreme cases been blamed for the extinction of other fish stocks, such as many forage species (fathead minnows, golden shiners etc.) and even rainbow trout. The aggressiveness of the largemouth bass also makes it a threat to other species which share its feeding habits.

The introduction of the Florida largemouth bass into waters inhabited by the northern largemouth bass can be damaging to the native subspecies. This would not create a superior fishery, as is typically hoped, but result in hybrid bass who demonstrate lower levels of the desirable traits possessed by both subspecies.

KERR, S. J. and R. E. GRANT. 2000$_b$. Smallmouth bass – Potential interactions and impacts. p. 413-414 *In* Ecological Impacts of Fish Introductions: Evaluating the Risk. Ontario Ministry of Natural Resources. Peterborough, Ontario. 473 p.

The impacts of smallmouth bass as predators are poorly understood. The knowledge that this species preys upon walleye fry has led to the recommendation that smallmouth bass not be planted in a percid community. In larger lakes it is possible that the two species could coexist. Competition for food and spawning space does exist between rock and smallmouth bass and therefore this should be taken into account when stocking lakes. Smallmouth bass are known to negatively impact brook trout, but appear to have little or no effect on lake trout.

Smallmouth bass have a tendency to carry parasites and there is the ever-present possibility that transplanted or improperly-reared fish could introduce a foreign disease into a water system, thereby infecting the native species of fish.

KING, W. 1942. Lake management studies in the Sandhills wildlife management area. Transactions of the American Fisheries Society 72 : 204-211.

The North Carolina Division of Game and Inland Fisheries is developing a wildlife management area, including several lakes, in the Sandhills country of the south-central part of the State. The lakes are being developed and managed for public fishing. Three lakes were opened for the first time in 1941, and in 1942 four lakes were opened for public fishing. All lakes were stocked with largemouth black bass (*Huro salmoides)*, and mixed bluegills (*Lepomis macrochirus macrochirus*) and *L. m. purpurescens*. Special permits were sold, and all catches were weighed and measured. A season of 10 weeks was permitted in 1941, and one of six weeks in 1942. In 1941, 769 successful anglers caught 5,127 fish, weighing 2,611 pounds, from 121 acres of water. In 1942, 343 successful anglers caught 1,649 fish, weighing 853 pounds, from 142 acres of water. Two lakes opened in 1942 for the first time, following stocking with legal-length largemouth black bass and bluegills, showed returns of 38% of the bass and 25% of the bluegills in one lake and returns of 10% of the largemouth bass and 7% of the bluegills in the other lake. This percentage of recapture throws some doubt on the advisability of stocking a new lake with legal-length fish in preparation for opening it to public fishing. There is evidence that the application of commercial fertilizer increased the yield of fish in one lake. Additional new lakes are under construction, and excellent opportunities will be presented for future studies in management and fish production.

KING, W. 1960. A survey of fishing, in 1959, of 1,000 ponds stocked by the Bureau of Sport Fisheries and Wildlife. Circular 86 of the Bureau of Sport Fisheries and Wildlife, Washington. Progressive Fish Culturist 22(3) : 128.

To evaluate its program of stocking farm and ranch ponds with fish produced at the national fish hatcheries, the Bureau of Sport Fisheries and Wildlife surveyed 1,000 ponds during December 1959 and January 1960. These ponds represented 2.5% of the ponds stocked in 1957.

Eighty-two percent of the ponds gave satisfactory or excellent fishing. Too many bluegills, silt or muddy water, and wild fish were most often blamed for the unsatisfactory fishing in other ponds.

The ponds provided fishing at the rate of 64 fisherman-days per acre. The average catch was 54 bass and 276 bluegills and other sunfish per acre. Catfish and bullheads contributed to the fishing in 20% of the ponds.

Assuming a productive life of at least 5 years, and projecting the fishing rate of 1,000 ponds to all those stocked by the Bureau, it was estimated that the program made 20 million man-days made available to 5 million persons.

KIRK, S. D. 1999. Trends in private pond management. Presented at the 1999 Southern Division of the American Fisheries Society mid-year Meeting. Chattanooga, Tennessee. (Abstract only)

Trends in small impoundment management are directly influenced by the desires of pond owners. Pond owner interests were assessed via a mailed questionnaire from October 1, 1998, through December 16, 1998. Survey questions were targeted at obtaining information pertaining to pond owners' management goals and activities related to their goals. Information requests included, but were not limited to, fertilizing and stocking histories, owner estimates of the average size of fish harvested, and angler satisfaction. Other current trends include threadfin shad stocking and reduced stocking rates of largemouth bass. Results from this survey indicate the services and management strategies both private and public pond managers should offer in order to maintain quality pond care.

KLEINSASSER, L. J., J. H. WILLIAMSON and B. G. WHITESIDE. 1990. Growth and catchability of Northern, Florida and F_1 hybrid largemouth bass in Texas ponds. North American Journal of Fisheries Management 10(4) : 462-468.

Fish from two genetically identified populations of largemouth bass (*Micropterus salmoides*), representing the northern subspecies (*M. s. salmoides*) (N x N) and the Florida subspecies (*M. s. floridanus*) (F x F), and their reciprocal F_1 hybrids (F x N and N x F; female represented first) were stocked in 0.04-0.48-ha ponds and evaluated for growth, condition and percent survival during the second year of life. Angling and seine-capture vulnerability were also examined. The F x N cross was significantly heavier and had a significantly higher relative weight (100 [individual weight/standard weight at length]) than the other crosses at the end of the study. The F x F cross was significantly shorter, weighed less, and was in poorer condition than all other crosses. The N x N was generally more susceptible to angling than the F x F cross. The F x F cross was significantly less vulnerable to seine capture than the other three crosses.

KRIEGER, D. A. 1983_a. Warmwater fisheries investigations: Black bass harvest regulations and supplemental stocking. Colorado Division of Wildlife. Denver, Colorado. 54 p.

KRIEGER, D. A. 1983_b. Evaluation of stocking yearling largemouth bass in Chatfield Reservoir, Colorado. Proceedings of the Annual Meeting of the Colorado-Wyoming Chapter of the American Fisheries Society 18 : 54-59.

KRIEGER, D. A. and S. PUTTMAN. 1986. Evaluation of supplemental stocking of yearling largemouth bass in Chatfield Reservoir, Colorado. p. 311 *In* G. E. Hall and M. J. Van Den Avyle [eds.]. Reservoir Fisheries Management: Strategies for the 80s. American Fisheries Society, Southern Division. Bethesda, Maryland.

Largemouth bass (*Micropterus salmoides*) were hatchery-reared to one year of age using intensive and extensive culture from 1978 to 1981. Each cohort was identified by a fluorescent pigment applied to the fish using compressed air and was stocked into Chatfield Reservoir at a length of approximately 125 mm. Stocking rates, which were based on a "habitat-acre" (H. A.) and took into account only littoral bass habitat, varied from 10 to 54/H. A. dependent on supply. The contribution of stocked bass, as a percentage of all bass in the same year class, was determined by electrofishing one year after stocking.

Stocked largemouth bass composed 12%, 59%, and 59% of all age-2 bass collected during 1980, 1981 and 1982, respectively. Growth of stocked bass exceeded that of natural bass, which may have been due to selection of aggressive feeders during intensive culturing of stocked bass. Bass marked in 1981 and held as a control group showed mark retention of 75% for one year. Only small amounts of pigment were retained after one year with granules located under lateral and ventral scales at the bases of the pectoral fins.

KRUMHOLZ, L. A. 1950. New fish stocking policies for Indiana ponds. Transactions of the North American Wildlife Conference 15 : 251-270.

In Indiana, as in ponds elsewhere, the correct solution to initial stocking policies lies largely in the type of fish or fishes stocked. The decision should be based upon the need to establish a population where all species will be contributing to the angler's catch. Preferably, these species will not be in direct competition for food and none should possess the reproductive potential to crowd out the other species.

The ideal combination would involve redear sunfish with either the spotted or largemouth bass. The redear is recommended as opposed to the bluegill because it is not so prolific. In the great majority of ponds that have been stocked with largemouth bass and bluegills, the bluegills usually become so numerous within 3 to 5 years following the original planting that they become stunted and begin to compete with small bass for food. No instance is known in which redear sunfish have seriously outnumbered the largemouth or spotted bass, which the bluegills tend to do.

If bluegills must be stocked in a pond in Indiana, a secondary predatory species must also be stocked along with spotted or largemouth bass. Rock bass or crappies are well suited for this job.

If a pond is to be stocked with only one species of fish it is recommended that rock bass, hybrid sunfish or cautiously channel catfish be stocked.

Stocking policies for small ponds that advocate the initial plantings of large numbers of fish are both extravagant and costly and are unnecessary for ponds in Indiana. When only relatively few fish are planted they will grow rapidly because of the abundant food supply and will soon reach sizes desirable to the angler within a year's time.

Our experiments have shown that it makes little difference in the future population of the pond whether one stocks 1,000 redear sunfish and 1,000 bass or only 100 of each. There is no basis for the belief that a stocking ratio of 1,000 bluegills and 100 bass per acre, is any better than 100 of each kind in Indiana.

For stocking the following combinations of species (in number per acre) in any Indiana pond for the first time is recommended:

- 100 redear fingerlings and 100 largemouth or spotted bass fingerlings
- 200 rock bass fingerlings alone
- 200 channel catfish fingerlings alone
- 500 hybrid sunfish fingerlings alone

No matter how small the pond is it is better to put in enough fish for at least one-half acre.

If it is imperative bluegills be stocked, we recommend no more than 50 bluegill fingerlings along with at least 100 bass fingerlings and either 100 rock bass or crappie fingerlings per acre.

Ponds smaller than 0.1 acre are usually too small to furnish any more than a very limited amount of fishing. However, we had good success when stocking such ponds with redear sunfish and either largemouth or spotted bass.

KRUMHOLZ, L. A. 1952. Management of Indiana ponds for fishing. Journal of Wildlife Management 16(3) : 254-257.

Presently there exist over 7,500 farm ponds in Indiana which are suitable for fish life. Personnel from the Indiana Lake and Stream Survey have been actively researching fish stocking on farms. Numerous species of fish have been involved in experimental stocking efforts in a variety of combinations:

- Redear sunfish, bluegills and largemouth bass;
- Redear sunfish, bluegills, and smallmouth bass;
- Redear sunfish with largemouth bass;
- Bluegills with largemouth bass;
- Rock bass, bluegills, and largemouth bass;
- Yellow perch, bluegills, and largemouth bass;
- Largemouth bass have also been stocked alone.

All plantings which were made were done with fingerlings in the late fall of the year. The numbers of bass planted ranged from 100 to 500 fingerlings per acre and redear sunfish ten percent of to twice the number of bass. The combination of bluegills and bass in Indiana has always resulted in an overpopulation of bluegills and for this reason is discouraged. Bluegills in combination with bass and another predatory species such as rock bass provide satisfactory results. Most ponds in Indiana are capable of giving sustained annual yields of more than 150 pounds per acre, although this rarely occurs due to inadequate fishing.

KUEHN, J. H. 1982. Lake management planning guide. Special Publication No. 132. Division Minnesota Department of Natural Resources, Fisheries. St. Paul, Minnesota. 61 p.

Largemouth bass are currently distributed throughout the waters of Minnesota, excluding a few deep cold lakes and Lake Superior. Management suggestions on improving poor largemouth bass populations include suggestions such as: avoiding large predator populations, assuring there exists adequate forage, rehabilitating degraded habitat, regulating fishing pressure and ensuring that proper stocking techniques are used.

In order to avoid the negative effects of low/no oxygen conditions which ultimately kill the stocked population, it is suggested that fish should be stocked following winterkill. It is important to also time your stocking with that of bluegills or at least be aware of the availability of forage shortly following ice break-up. The simplest method of establishing a new population involves the planting of brood stock at a density of one pair for every ten acres, shortly after ice-out. Fry stocking has also shown positive results. If fingerlings are preferred it is recommended that the stocking rate be 50-100 fish/acre of water.

Evaluation of plantings is essential in order to calculate which stocking rate is best for a particular body of water. If constant stocking is necessary to provide a largemouth bass fishery, then management is not likely to be economically feasible.

Smallmouth bass prefer cooler waters than do the largemouth bass and they are highly successful in the areas of northeastern Minnesota which contain clear, rocky lakes. They do not thrive under eutrophic conditions. The success of introducing smallmouth bass into lakes dominated by walleye and centrarchids has been mixed. If there exists ample smallmouth bass habitat, they will likely flourish, yet they will also manage to displace and generally have a negative effect on the walleye population.

KUHN, D. 1980. Minnesota small pond project yields interesting results, variety of fish. Aquaculture Magazine 6(3) : 32-33.

In 1979, Meredith Olson, a graduate student, initiated a project in Wright County, Minnesota to encourage farmers to use their ponds to grow their own food. Of the fifteen ponds, ranging from 0.5 to 5 acres, ten were considered warm-water. Warm-water ponds were stocked with various combinations of channel catfish, bullheads, bluegills and bass. Bass and channel catfish were purchased from private hatcheries. The fish were stocked at relatively low densities and for the most part ate natural food. Despite success with the bullheads, channel catfish and bluegills, the bass disappeared from the ponds. Seining, trapping and angling efforts failed to retrieve any bass from the two ponds in which they had been stocked six months earlier.

KULZER, K. E., R. L. NOBLE and A. A. FORSHAGE. 1985. Genetic effects of Florida largemouth bass introductions into selected Texas reservoirs. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 39 : 56-64.

Florida largemouth bass (*Micropterus salmoides floridanus*) have been stocked extensively into Texas reservoirs containing the northern largemouth bass (*M. s. salmoides*) subspecies, and knowledge of the genetic makeup of these potentially intergraded populations is important to their continued management.

Bass populations from 19 such reservoirs were analyzed by electrophoretic determination of individual fish genotypes. As measured by variation at 3 loci, intergradation ranged from 2% to 92%. Variations in percent intergradation among reservoirs were related to individual reservoir conditions and Florida largemouth bass stocking histories. Regression analysis suggested that repeated annual stocking of Florida largemouth had the greatest effect on the frequency of Florida largemouth bass genes. Water clarity and total number of Florida largemouth bass stocked were correlated with intergradation rate, but did not explain significant additional variation beyond that due to number of years stocked.

KURTEN, G. 2000. Analysis of stocking and harvest variables in earthen Florida largemouth bass fingerling rearing ponds. Presented at the 2000 Joint Meeting of the Arkansas, Louisiana, and Texas Chapters of the American Fisheries Society. Bossier City, Louisiana. (Abstract only)

Six years (1992-1997) of data from 197 Florida largemouth bass (*Micropterus salmoides floridanus*) rearing ponds was analyzed to examine the relationships between fingerling harvest variables and fingerling stocking variables and zooplankton densities. Fish growth was the most reliably predicted harvest variable ($r^2 = 0.44$). Growth was adequate to produce 38-mm fingerlings at maximum fish stocking densities of 690,000 fish/ha only if Cladoceran and Copepod densities were at the highest values for the dataset. Fish survival increased with fry stocking size. The optimum stocking size to provide 60% survival of fingerlings was about 20 mm. Harvest biomass and harvest length appeared to be improved by lengthening the interval between pond filling and fish stocking. Harvest density was improved by increasing one indicator of fish stocking size; stocking biomass and by increasing stocking densities. Survival seemed to be a poor indicator of production success because, while survival rates decreased with stocking density, actual harvest densities increased. Zooplankton densities at stocking and at seven days after stocking were, generally, weak indicators of harvest variables. However, Cladoceran and Copepod nauplii densities at stocking and Rotifer densities at seven days after stocking appeared to be significant indicators of fish production success. The low correlation of fish production and zooplankton variables and the indication that lengthening the pond filling to stocking interval improves harvest biomass and harvest length seem to indicate that managing for immigration and development of other, larger pond invertebrates may improve fish production above managing for zooplankton alone when the target production size for Florida largemouth bass fingerlings is 38 mm.

LAARMAN, P. W. 1979. Evaluation of a chemical reclamation and restocking program on the Huron River in the Detroit Metropolitan area. Dingell-Johnson Project MI F-35-R. Michigan Department of Natural Resources. Lansing, Michigan. 34 p.

Approximately forty miles of the Huron River, including seven impoundments were treated with 2 ppm of rotenone. This treatment was conducted on three segments between October 1972 and October 1973. More than 17 million desirable fish were stocked following the eradication of more than 1,000 metric tons of unwanted species (95% carp). In Ford Lake, one of the three segments, 233 yearling largemouth bass, 254,038 fingerling largemouth bass and 107,940 fingerling smallmouth bass were stocked.

The major evaluation was done by post treatment creel censuses on the three segments (Belleville Lake, Ford Lake and the "upper" section). The benefit to cost ratio over a five year period was calculated for each segment. The ratio for the "upper" segment was found to be 4.1:1, that of Ford Lake 5.7:1 and that of Belleville Lake 25.3:1. Although the number of stocked predators which were harvested by anglers was low, all but muskellunge showed up in the creel. Largemouth and smallmouth bass accounted for 4% of the total harvest.

LARIMORE, R. W. 1954. Dispersal, growth and influence of smallmouth bass stocked in a warmwater stream. Journal of Wildlife Management 18(2) : 207-216.

Smallmouth bass were added to a known indigenous population of this species in Jordan Creek. The survival, growth, and dispersal of both the native and stocked fish were followed to determine factors controlling the population density of bass in small streams.

Five groups of smallmouths, mostly yearling fish, were released in Jordan Creek between July, 1951 and April, 1952. Four of these groups were composed of pond-reared bass; the other group consisted of fish from nearby Stony Creek. A total of 248 fish were released, which was 1.3 times the total number of smallmouths taken in the 1950 census of Jordan Creek.

The four-mile study area of Jordan Creek was censused one year before (1950) and one year after (1952) the new bass were stocked. These censuses served as a basis for judging the preliminary results of stocking. Most of the fish in each group moved upstream from where they were released. The July-September census of 1952 showed that 75% of the pond-reared bass were still in the one-half-mile division upstream. The smallmouths from Stony Creek revealed no special pattern of distribution but were scattered singly up and down the stream.

The longer the pond-reared fish were in the stream, the greater was their tendency to remain in one place. By the fall of 1952, most of these bass were claiming home pools, at least temporarily.

Growth of the stocked bass during their first season in Jordan Creek was as good as that of the indigenous smallmouths. There was no indication in this season that competition of the stocked bass affected the growth of the native smallmouths. Only slight differences were evident between the growth rates of the four groups of pond-reared fish.

Thirty-four percent more smallmouths (excluding fingerlings) were taken in the 1952 census of the entire study area than in the 1950 census. The number of legal-sized bass was 60% greater. The increase in numbers was approximately equivalent to the number of stocked fish retaken. There was no evidence in the year after the stocking that the introduced bass caused a decline in the total number of native smallmouths.

The number of native smallmouths dropped off considerably in several pools containing concentrations of stocked fish. The decline may have been caused by the moving of native fish to other parts of the stream or by lack of replacement by native fish for those removed by anglers.

LAWSON, C. S. and W. D. DAVIES. 1978. Effects of bass stocking and rates of fishing on a largemouth bass population. Proceedings of the Annual Conference of Southeastern Association of Game and Fish Commissioners 31 : 493-497.

Supplemental stocking of fingerlings and intermediate size largemouth bass (*Micropterus salmoides*) did not provide substantial control of forage fish populations; however, stocking fingerling bass may have improved year class strength in those years they were stocked. Although loss of stocked intermediate-size bass over the spillway was negligible, those fish were vulnerable to angling. A measured rate of fishing (F = 0.08) was exerted on a population of bass estimated at 22.3 harvestable bass/ha weighing 34 kg/ha.

LEACH, G. C., M. C. JAMES and E. J. DOUGLASS. 1940. Propagation and distribution of food fishes, fiscal year 1939. Report of the United States Fishery Commission, 1939 : 555-598.

LEITNER, J. and J. BULAK. 2000. A reciprocal transplant study for the comparison of two genetic strains of largemouth bass in South Carolina. Presented at the Black Bass

Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

A statewide reciprocal transplant study was initiated to compare the performance of two strains of largemouth bass. South Carolina is located in the broad hybrid zone that exists between the ranges of the northern and Florida subspecies of largemouth bass. Allozyme surveys have shown South Carolina coastal largemouth bass populations possess 98% Florida alleles, while Piedmont populations possess as few as 36% Florida alleles. Thirty seven new or renovated farm ponds were stocked in 1994 and 1995 with fingerlings produced from either the coastal or Piedmont strain of largemouth bass. We characterized performance differences between the two strains by evaluating growth of original stocks at one and three years. We are also monitoring the change in allele frequencies over subsequent year classes. Selected water quality parameters were monitored to define productivity differences among ponds. Region (Coastal Plain or Piedmont), strain, and the interaction of region and strain were tested as predictors of growth rate for first year and third year growth. Differences between regions were significant ($P = 0.05$) for growth at age-1 and at age-3, with fish stocked in the Coastal Plain growing faster. Differences due to strain and the region/strain interaction were not significant. Collection and genetic analysis of subsequent year classes are on going. A shift in allele frequencies over successive generations can provide direct evidence as to what genetic strains, if any, are selected for in each region.

LEWIS, W. M. and R. C. HEIDINGER. 1973. Fish stocking combinations for farm ponds. Bulletin No. 4, Southern Illinois University. Carbondale, Illinois. 17 p.

LITTKEMANN, P. 1960. Biological report on Steenburg Lake in Limerick and Tudor Townships, Hastings County, June 3rd to June 8th, 1960. Department of Lands and Forests. Tweed, Ontario. 24 p. + appendices.

A lake survey was conducted on Steenburg Lake which consisted of test fishing with trap nets and gill nets, collecting scale samples from all game and non-game fish and recording total length; conducting pH tests, Secchi disc readings; identifying aquatic vegetation; using past fishing information to improve current management; and observing the progress of pickerel introductions made in 1959.

Largemouth bass are currently the most abundant game species in the lake. According to lake residents, this species is not native to the lake and it is unknown precisely when it was introduced. Department of Lands and Forests records show that planting began in 1952, although bass aged 14 and 15 years were captured. The third year class was found to be the strongest in the lake, due to excellent spawning conditions during the summer of 1957. Presently, there is no need for further plantings of hatchery largemouth bass.

The smallmouth bass is the second most common gamefish in Steenburg Lake. It also is a non-native. The initial planting occurred in 1914 and was comprised of 30,000 fingerlings. Over the following 41 years approximately 82,070 individuals were planted into the lake. The current population level of smallmouth bass does not warrant further plantings with hatchery fish.

LITTLE, R. G. 1959. Stocking procedures and survival on the Atrisco Drain. Dingell-Johnson Project NM F-10-R-4, Job C-5. New Mexico Department of Fish and Game. Santa Fe, New Mexico. 14 p.

LIVINGSTON, B. D. 1989. Species composition and abundance changes in Broadfoot Pond, 1978-1988. Ontario Ministry of Natural Resources. Lindsay, Ontario. 73 p.

Population structure changes were studies in a 1.5-ha pond near Lindsay, Ontario from 1978-1988. Yellow perch (*Perca flavescens*) were last observed in 1982. All specimens captured at this time were female, which prevented successful recruitment of the population. Brown bullheads (*Ictalurus nebulosus*) were abundant in 1978, but have decreased to where no specimens were caught in 1988. A species-specific disease is believed to be the cause of the brown bullhead demise. A successful spawning contributed to the large walleye present in 1978. Increased sedimentation of the pond substrate has prevented walleye from successfully spawning. Silting has been contributed to by cattle trampling the banks and the natural aging of the pond. This has also been a factor of the decline of white suckers (*Catostomus commersoni*) in the pond. Walleye and white suckers will both eventually die out completely, as shown by the few older fish now present. Both smallmouth bass (*Micropterus dolomieui*) and rock bass (*Ambloplites rupestris)* have declined from 1978 but have reached a steady population level at the present time. Young smallmouth bass numbers have shown an increase since 1982. Adult pumpkinseed (*Lepomis gibbosus*) declined from 1978 to 1986 but have since increased. Young pumpkinseed are the most abundant species in the pond. A total of 39 largemouth bass (*Micropterus salmoides*) have been introduced in 1986-1987 to help control their numbers. The largemouth bass have become established and have shown successful spawning in both 1987 and 1988. Young largemouth bass are three times as abundant as smallmouth bass. A decline in smallmouth bass could be seen in the future due to competition with the introduced fish. Growth of young of the year and yearling largemouth bass is considered average when condition coefficients and lengths were compared to the literature.

A potential yield of 4.52 kg/ha is expected from Broadfoot Pond. It is recommended that future species composition trends be monitored using methods from previous years, with emphasis on the largemouth bass-pumpkinseed relationship.

LOBLAW, R. E. and R. J. CAWTHORN. 1970. Kernick (Pike) Lake, lake survey summary sheet. Ontario Department of Lands and Forests. Parry Sound, Ontario. 2 p.

In 1950, 120 smallmouth bass were transferred from Skeleton Lake into Pike Lake.

LOCKARD, F. R. 1971. Cost-analysis of adult stocking: Hatchery to creel. p. 222-223 *In* R. J. Muncy and R. V. Bulkley [eds.]. Proceedings of the North Central Warmwater Fish Culture – Management Workshop. Iowa Cooperative Fishery Unit, January 21-22, 1971, Ames, Iowa.

Using Monroe, Indiana's largest flood control reservoir, I will attempt to demonstrate how Indiana stocks its reservoirs and provide a cost analysis of this process.

Monroe was eradicated of the majority of the "undesirable" species of fish and adult largemouth bass were stocked to promote a bluegill fishery. There was some difficulty in rearing the largemouth bass to near maturity (80% sexually mature), yet 14,000 bass, ranging from 6.5 to 12.5 inches, were stocked prior to the 1965 spawning season in Monroe at a total cost of $22,400 or $1.60 each.

The stocking rate was 1 per surface acre and it was hoped that the fish would serve as brood stock as well as eliminate undesirable species and the bluegill recruits to provide quality bluegill fishing. Currently, 6 years following the initiation of Monroe's stocking program, the reservoir has shown considerable success. Survey samples revealed that the largemouth bass comprised 93.1% of the total fish population in 1965, 66.8% in 1966, 66.1% in 1967, 33% in 1968, and by 1969 the largemouth bass were no longer the dominant species. The population of bass was found to be slow-growing, yet it enabled the bluegill fishery to thrive.

I conclude that adult largemouth bass stocking is more important in cases where they are needed immediately in a predatory capacity. It is unknown whether this type of reservoir stocking will be successful in the long run and fisheries personnel must be kept flexible when testing new stocking ideas.

LOPINOT, A. C. 1973. Evaluation of ponds stocked with a ratio of ten sunfish to one largemouth bass. Fisheries Report 39. Illinois Department of Conservation. Springfield, Illinois. 9 p.

LOPINOT, A. 1993. Smallmouth bass in farm ponds. Farm Pond Harvest 27(3) : 16, 22.

LOPINOT, A. 1999. Stocking the farm pond. Farm Pond Harvest (Illinois) 33(2) : 24-26.

LOSKA, P. M. 1982_a. Stocking bass to improve your fishing – is it the key to better fishing? Bass Research Foundation Special Report. Starksville, Mississippi.

LOSKA, P. M. 1982_b. A literature review on the stocking of black bass (*Micropterus* spp.) in reservoirs and streams. Georgia Department of Natural Resources. Atlanta, Georgia. 19 p.

LOWMAN, F. G., Jr. 1958. Introduction of smallmouth bass, *Micropterus dolomieu*, in the upper regions of the Llano River lying within Sutton, Edwards and Kimble counties, Texas. Dingell-Johnson Project TX F-9-R-5, F-1, Segment Completion Report. Texas Parks and Wildlife Department. Austin, Texas. 3 p. (mimeo)

LUTTERBIE, G. 1993. The use of supplemental stocking to restructure largemouth bass populations in lakes where traditional fisheries management methods were ineffective or restricted. *In* Managing Black Bass in Northern Waters. New York Chapter of American Fisheries Society. Alexandria Bay, New York.

In large potable water supply lakes many traditional management strategies cannot be used to manipulate fish populations. The use of fishing regulations had no major impact on improving the largemouth bass (*Micropterus salmoides*) population. As a result a cooperative supplemental stocking program was implemented in 1990 to rebuild the severely deteriorated largemouth bass populations. Two lakes, Lake Bloomington and Evergreen Lake located in central Illinois, were each stocked with 11800, 50-200 mm largemouth bass in 1990; 2500 and 3000 respectively, 200 mm marked largemouth bass in 1991; and 3000, 200 mm marked largemouth bass in 1992. 1991 electroshocking survey results of the two lakes showed that bass stocked in 1991 comprised 26 and 80% of similar size largemouth bass captured. In 1992, largemouth bass stocked in 1991 comprised 44 and 62% of similar size bass; while bass stocked in 1992 made up 43 and 62% of similar size bass captured. The three year stocking program developed optimal catch per unit effort rates, PSD and RSD-380 mm values in each lake. The largemouth bass population characteristics developed due to this program represent the highest in the 20 and 30 year history of the lakes.

MacCRIMMON, H. R. 1967. The Newcastle Fish Hatchery, Newcastle, Ontario. University of Guelph. Guelph, Ontario. 2 p.

The Newcastle Fish Hatchery was the site of the first known attempt to rear smallmouth bass (*Micropterus dolomieui*) in 1872. Parent bass were removed from the Bay of Quinte, Lake Ontario, and placed into ponds to spawn, which they did so successfully.

MacCRIMMON, H. R., J. E. STEWART and J. R. BRETT. 1974. Aquaculture in Canada: The practice and the promise. Bulletin of the Fisheries Research Board of Canada No. 118. Ottawa, Ontario. 84 p.

MACEINA, M. J. 1987. Evaluation of Florida largemouth bass introductions into a new Texas reservoir: Factors regulating stocking success and introgression. Ph. D. Dissertation, Texas A&M University. College Station, Texas. 120 p.

MACEINA, M. J. and B. R. MURPHY. 1987. Florida largemouth bass stocking success, subsequent genetic introgression and survival in a new Texas reservoir. American Fisheries Society Annual Meeting 117 : 48. (Abstract only)

MACEINA, M. J., B. R. MURPHY and J. J. ISELY. 1988. Factors regulating Florida largemouth bass stocking success and hybridization with Northern largemouth bass in Aquilla Lake, Texas. Transactions of the American Fisheries Society 117(3) : 221-231.

We electrophoretically assayed four enzyme-encoding loci in, and determined the ages of, 11,534 largemouth bass (*Micropterus salmoides*) collected from a new Texas reservoir (Aquilla Lake) over a 41-month period. We used these data to evaluate stocking success and subsequent hybridization of the Florida subspecies *M. s. floridanus* (1.5-6.5 cm total length and age 0 when stocked between 1983 and 1985) with the indigenous northern subspecies *M. s. salmoides*. After these stockings, genomic inflow into the population from Florida largemouth bass was rapid. In the 1986 year-class, age-0 Florida largemouth bass, first-generation (F_1) hybrids between the two subspecies, and second- or higher-generation (F_x) hybrids were numerically dominant (72%). For these individuals, the frequencies of Florida alleles at two diagnostic loci (fixed allelic differences between subspecies) were 0.51 and 0.52, respectively. Although the subspecies hybridized extensively in 1986, the population at age-0 did not conform to expected Hardy-Weinberg genotypic proportions because the northern subspecies tended to breed earlier than the Florida subspecies. Higher relative survival rates were evident for hybrid and Florida largemouth bass than for the northern subspecies, and a size-dependent fecundity advantage for Florida largemouth bass females was due to their larger size by age 3.

MacFEE, J. A. 1957. Gogama District fish planting. Paper presented at the Kirkland Lake Fur Advisory Meeting, April 8-11, 1957. Ontario Department of Lands and Forests. Kirkland Lake, Ontario.

Planting records, which date to 1949, indicate that 500 smallmouth bass (*Micropterus dolomieu*) were planted in the Gogama District in 1956. There are proposed plantings of 1,000 for each of the years 1958 through 1961. To date, three introductions of this non-native species are known to have been made in Gogama district waters. The earliest, carried out more than 10 years ago, was successful, but few anglers seem interested in the large bass offered by that lake. A lake which received a more recent introduction was netted last year, but no bass were caught. The third planting took place in 1949. We are not in favour of establishing bass in this district. A few tourist outfitters are pressing for bass stock for small, land-locked lakes near their camps, but we are resisting them as much as possible, so our annual bass requirements should never amount to much. When Gogama is exposed to the main force of vacationers, we will need to create new fisheries and perhaps artificially maintain some of the existing ones.

MacKAY, H. H. 1960. Smallmouth black bass (*Micropterus dolomieu*). Sylva 16(5) : 25-34.

Although the original distribution of the smallmouth black bass included areas in Ontario, such as the Great Lakes watershed, the Ontario Department of Game and Fisheries decided that its range should include a larger part of the province. In 1901, and for several years following, large numbers of smallmouth bass were planted in various lakes across Ontario. In 1903, 400 adult bass were sent to Long Lake (near Lake of the Woods). Later, a destroyed dam allowed the fish access to Lake of the Woods and through this and other introductions into systems which were not isolated, the distribution of the bass has been extended from the Atlantic States to the Great Plains and the Gulf States into Canada. Currently, no more stocking is necessary in most areas since many lakes have populations which can maintain their own stock even in the presence of fishing.

MAITLAND, P. S. and C. E. PRICE. 1969. *Urocleidus principalis*, a North American monogenetic trematode new to the British Isles, probably introduced with the largemouth bass (*Micropterus salmoides*). Journal of Fish Biology 1(1) : 17-18.

The largemouth bass is native to North America, yet has been successfully introduced to areas of Africa and Europe. Populations in the British Isles are few and only occur in the south of England. *Urocleidus principalis* is host-specific parasite of the *Micropterus* and has been found on 12 separate occasions in North America. Recently it has been discovered in a largemouth bass from the British Isles and it is highly suspected that the parasite was imported along with the fish from North America.

MALLOY, T. P., A. A. ECHELLE and R. A. VAN DEN BUSSCHE. 2000. Genetic structure of mixed native/non-native smallmouth bass populations in two Oklahoma reservoirs. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

Recent genetic studies demonstrated that populations of smallmouth bass in Oklahoma represent 2 of the most divergent lineages of this species: the Neosho lineage in northeastern Oklahoma and the Ouachita lineage in southeastern Oklahoma. Between 1991-93, the Tennessee Lake strain of smallmouth bass was introduced into Tenkiller Reservoir in northeastern Oklahoma and Broken Bow Reservoir in the southeast. There is some indication that smallmouth bass fisheries in Tenkiller and Broken Bow reservoirs have improved since the introductions. Our purpose was to develop nuclear DNA markers (microsatellites) that can be used to examine the relationship between age, growth, and genetic status (native, non-native, hybrid, and backcross progeny) of individuals. We have identified 3 markers that are diagnostic for Broken Bow Reservoir and 1 that is diagnostic for Tenkiller Reservoir. Results indicate that both populations are panmictic admixtures of natives and non-natives, with non-native alleles forming about 40% of the genome in Broken Bow and 90% in Tenkiller. This genetic structure makes it difficult to assess relative age and growth rates among genotypes.

MARSHALL, T. L. and R. P. JOHNSON. 1971. History and results of fish introductions in Saskatchewan. Fisheries Report No. 8. Department of Natural Resources, Fish and Wildlife Branch. Regina, Saskatchewan. 32 p.

Since 1900, 1.6 billion fish comprising 30 species have been introduced to the fresh and saline waters of Saskatchewan.

Indigenous species have been widely distributed into saline and new waters including lake whitefish (*Coregonus clupeaformis*). The ranges of Arctic grayling (*Thymallus arcticus*) and lake trout (*Salvelinus namaycush*) have been extended southward. Introductions of a few "minnows" and catostomids as forage for other species were made but never assessed.

Exotic species that have exhibited natural reproduction include the largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieui*) and a few trout species. Survival without reproduction has also occurred and the introduction of coho salmon (*Onchorhynchus kisutch*) remains to be assessed.

Recommendations for fish introductions began as early as 1887 and shortly saw the demand for bass fishing. Initiating in 1923, largemouth bass began making their way into Saskatchewan from the United States. Most of the first stocks came from North Dakota, yet later introductions in 1951, 1955 and 1969 originated in Montana. The species has been introduced into 23 lakes and reservoirs south of latitude 54° N. The seventeen introductions made into eutrophic lakes prior to 1950 failed. It is suspected that winterkill and the presence of predators was to blame. The plantings made in 1951 and 1955 appear to be doing well. Two reservoirs still contained bass in 1965 and 1969, although both have since been wiped out by winterkill. Willows Reservoir has demonstrated natural reproduction and as of yet the population is healthy.

Smallmouth bass have only been introduced into three lakes in Prince Albert National Park and observations are largely based upon the work of D. S. Rawson. The first planting in 1931, of adults, failed. Five years later the introduction of 263,000 fry and adult fish proved only somewhat successful as there was no evidence of lake-hatched fry surviving to maturity. The extreme temperatures greatly affected the smallmouth bass and its ability to survive. Bass were found for several years after the plantings, unfortunately none produced fry that survived.

MARTIN, C. C. 2000. The use of advanced fingerling stockings to enhance natural reproduction in a tidal river largemouth bass population. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

The tidal largemouth bass population of the Nanticoke River/Broad Creek system supports a popular fishery in Delaware. Historical monitoring of the bass population has indicated that reproduction and/or recruitment are limited, possibly by the tidal environment. Annually since 1995, adult bass collected from Broad Creek have been allowed to spawn in small ponds and the resulting fingerlings returned to the system. All fingerlings have been marked with coded-wire tags (CWTs) prior to their release into the River. The impact of the stocking has varied depending on the strength of the naturally-produced year class. By 1998, stocked fish represented about 15% of the 1995, 1996 and 1998 year classes. The 1997 year class was little impacted by stocked fish due to high stocking mortality and a very strong naturally produced year class. Recruitment into the sport fishery was documented by the presence of CWT-bass in fishing tournaments as early as fall 1996. Several cooperators, the Delaware B.A.S.S. Federation, the Dupont Seaford nylon plant, Conective (an electric utility), and the MD Department of Natural Resources, have provided assistance with the program.

MARTIN, N. V. 1953. The creel census and fish management in Algonquin Park. File Report. Ontario Department of Lands and Forests. Whitney, Ontario. 8 p.

Since 1935 data have been recorded for a number of Algonquin Park lakes on the species of fish caught, their number, size, and ease of capture. Hatchery bass have been planted in some of the easily accessible lakes adjacent to Highway 60. Transfers of adults have been undertaken in the past, mainly adult fish into Cache Lake and Lake of Two Rivers. In Cache Lake a return of only 17% of the number planted was observed. The major bass fishery remains Lake Opeongo where total annual catches have varied from 200 in the latter years of World War II, to 1600 in 1950.

MARZOLF, R. C. 1954. Fisheries management planning and research: Practicality and economic feasibility of rearing and stocking largemouth bass of one pound size. Dingell-Johnson Project MO F-1-R-3, Job No. 1. Missouri Conservation Commission. Jefferson City, Missouri. 21 p.

MAUCK, P. E. 1984. Evaluation of Florida and northern largemouth bass when stocked into new small impoundments. Dingell-Johnson Project F-39-R, Job No. 6, Objective No. 6, Final Report. Oklahoma Department of Wildlife Conservation. Oklahoma City, Oklahoma. 36 p.

MAYES, K. B., P. M. ROSENBLUM and T. M. BRANDT. 1993. Raceway spawning of Florida largemouth bass: Effects of acclimation time and hormone treatment on spawning success. Progressive Fish Culturist 55(1) : 1-8.

Several acclimation periods and hormone treatments were tried to determine their effects on controlled spawning of 2-year-old Florida largemouth bass (*Micropterus salmoides floridanus*). During the first season, fish were acclimated to raceways for 0-8 weeks before spawning; males and females were separated during acclimatization. There was an inverse relationship between the length of the acclimatization period and latency of first spawn after the sexes were mixed. The longest acclimatization periods resulted in the shortest latencies, however, once spawning began. The rate of spawning (interval between spawns) was similar across treatments. During the second season, unacclimated and 2-week-acclimated largemouth bass were injected with saline, human chorionic gonadotropin (HCG; 4,000 IU/kg body weight) or [D-ala^{6}pro^9-*N*-ethylamide]-luteinizing hormone releasing hormone (LHRH-A; 0.5 mg/kg body weight). Injections of HCG induced spawning quicker, and produced more spawns and fry, than did injections of LHRH-A or saline. Acclimated largemouth bass produced more spawns than did unacclimated largemouth bass in all treatments. Acclimatization periods may have allowed stress associated with common fish culture practices to diminish and may have provided time for synchrony to develop between male and female largemouth bass. In the last experiment, injections of HCG in females alone resulted in spawns within 48 h; however, spawns did not produce fry. This was attributed to a lack of synchrony with males, possibly resulting in over-ripeness of eggs. These results show that optimum spawning can be achieved when largemouth bass are allowed to acclimate to raceway conditions for 2 weeks, and that HCG treatment of both sexes is the preferred hormone treatment for induction of spawning.

McLEOD, H. A., C. A. CRAIG and J. L. CREIGHTON. 1975. A limnological survey of Constance Lake. File Report. Ontario Ministry of Natural Resources. Ramsayville, Ontario.

By examining the stocking records of Constance Lake it was found that adult smallmouth bass were planted in 1930 and largemouth bass fry in 1953. Beginning in 1954 largemouth bass fingerlings were planted every two years until 1966. It appears unlikely that the stocking made any significant impact on the quantities of adult stock.

McDOWALL, R. M. 1968. The proposed introduction of the largemouth black bass (*Micropterus salmoides*) into New Zealand. New Zealand Journal of Marine and Freshwater Research 2 : 149-161.

McINTYRE, E. J. 1982. 1981 assessment of some largemouth bass introductions in Parry Sound District, 1976-1978. File Report. Ontario Ministry of Natural Resources. Parry Sound, Ontario. 4 p.

During the summer of 1981, six lakes were assessed to determine the success of 1976 and/or 1978 adult largemouth bass introductions to establish self-sustaining populations. Assessment was also conducted on the 1976 planting of 5,000 summer fingerlings (largemouth bass) in Storm Lake (Christie Township). A high degree of success was observed in Axe Lake (McMurrich, Monteith and Stisted Townships) and Storm Lake. Moderate success was observed in Wiwassasegen Lake (Carling and Shawanaga Townships) and Manitouwaba Lake (Christie Township). Little success was observed in Horn Lake (Monteith Township) and Mowat Lake (Mowat Township).

McINTYRE, E. J. 1983. Largemouth bass introductions made in the Parry Sound District in 1982. File Report. Ontario Ministry of Natural Resources. Parry Sound, Ontario.

This paper discusses the specifics of the largemouth bass planted in the Parry Sound District in 1982. Information on the origin of stock (i.e., name of lake), number and date of fish transplanted and recipient water body is presented.

McINTYRE, E. J. 1984. 1983 assessment of adult largemouth bass transfers made in the Parry Sound District in 1978 and 1979. File Report. Ontario Ministry of Natural Resources. Parry Sound, Ontario. iv + 6 p.

During the summer of 1983, four lakes were assessed to determine the success of adult largemouth bass introductions made in 1978 and 1979 in an attempt to establish self-sustaining populations. The project was considered a failure in Imrie Lake (Carling Township) which showed no signs of natural reproduction and almost no survival of the original planted fish. Nil to poor survival of original planted bass and minimal signs of natural reproduction were observed on Cranberry Lake (Harrison Township) and Whalley Lake (Chapman Township). Wilson Lake (Monteith Township) showed moderate success by establishing a small self-sustaining population.

McINTYRE, S. C. 1973. Effect of stocking year-old largemouth bass on the dynamics of black crappie in recently established largemouth bass-sunfish populations. Ph. D. Dissertation, Auburn University. Auburn, Alabama. 57 p.

McKEOWN, W. Undated. Volume 3: A compendium of historical reports concerning Lac Des Mille Lacs, Ontario. Ministry of Natural Resources. Thunder Bay, Ontario.

The interest at introducing new species to Lac Des Mille Lacs began in 1921 when a carload of adult smallmouth bass were stocked. Further plantings of this species were made in 1927, 1933 and 1937. All smallmouth bass plantings proved to be unsuccessful.

McNEILL, A. J. 1995. An overview of the smallmouth bass in Nova Scotia. North American Journal of Fisheries Management 15(3) : 680-687.

Introduced to Nova Scotia waters in 1942, smallmouth bass (*Micropterus dolomieu*) have provided an alternative fishery to the more popular brook trout (*Salvelinus fontinalis*) in local areas. In recent years, angler interest in smallmouth bass has increased dramatically, and a modest tournament fishery has developed in addition to noncompetitive angling. Since 1971, illegal transfers and movements of fish within watersheds have been responsible for approximately doubling the distribution of this species over the past 15 years. Estimated annual catch and average catch per angler increased 32-fold over the same time period. Population structure and length-at-age data from biological surveys done in 1992 and 1993 indicated that growth was slower than in other northern waters. Observations of smallmouth bass nesting activity suggested that nest building and spawning commence when water temperatures reach 16-18°C, which typically occurs at the end of May or the first week of June in Nova Scotia, and nest guarding is terminated by early July. Management practices focus on restricting the illegal introduction of smallmouth bass to new watersheds and sustaining a quality fishery where smallmouth bass are established.

MEEHEAN, O. L. 1952. Problems of farm fish pond management. Journal of Wildlife Management 16(3) : 233-238.

The first fish ponds in this country probably were mill ponds where an individual could pass the time with a hook and line as he waited to have his grain ground. Some of these ponds are being managed today.

Stocking rates that have proved satisfactory in new fish ponds consist of 100 bass and from 750 to 1,500 bluegill fingerlings per acre. When 1,500 bluegills are used their growth is slightly stunted. The Fish and Wildlife Service has recommended a rate of 100 bass and 1,000 bluegills per acre. Typically, in unfertilized waters, half of the recommended number is used. The bluegill-bass combination is most popular in pond stocking, yet they cannot grow properly in turbid waters and other combinations may need to be used. It is recommended by biologists, that a ratio of 100 bass and 200 bluegills per acre, or 200 bass and 200 bluegills be stocked.

In Indiana, 82% of the small ponds stocked with 200 bass and 200 bluegills per acre were found to be in balance. In contrast, only 27% of ponds in the Southwest provide excellent fishing. This simply demonstrates that not all areas of the United States should have the same criteria for pond stocking and construction, as climatic and environmental differences play a role in the success of pond culture.

MELLAN, G. 1987. Management suggestions for the largemouth bass fishery of Little Lake, South Crosby Township. File Report. Ontario Ministry of Natural Resources. Kemptville, Ontario. 3 p.

On July 10, 1987, a shoreline cruise was undertaken in the hopes of assessing the stocking of largemouth bass which had occurred in the lake years before. Largemouth bass were planted into the lake in the fifties and early sixties and was comprised of 500 to 800 fingerlings every two years until 1961. There are currently reports by landowners of five pound bass being captured with the average size of fish being 10-12 inches. The shoreline survey found adequate spawning areas, yet saw room for improvement. At this time landowners may wish to revive the stocking program yet there is little evidence to suggest that this will prove successful on top of an established population. It is highly recommended that habitat improvement, such as the addition of tires for bass spawning, be undertaken to improve the fishery.

MENSE, J. B. 1980. Fish research and surveys for Oklahoma lakes and reservoirs: Availability of forage to young-of-year wild and hatchery-reared largemouth bass. Oklahoma Department of Wildlife Conservation. Oklahoma City, Oklahoma. 51 p.

MERNER, F. H. 1958. A statistical report of the history of the stocking of the Grand River. Department of Lands and Forests, Southwestern Region, Conservation Officers Projects 1 : 23-25.

Records from 1928-1957 indicate that an extensive amount of smallmouth bass stocking occurred in the Grand River (311,000 fry and fingerlings in total). It is recommended that the stocking of smallmouth bass continue given that they have proliferated and are currently being caught in large numbers by anglers.

MILEWSKI, C. L. 1990. Evaluation of smallmouth bass introductions in South Dakota lakes. M. Sc. Thesis, South Dakota State University. Brookings, South Dakota. 90 p.

Objectives were to: (1) evaluate the influence of sampling gear (electrofishing gear and modified-fyke (trap) nets) and environmental characteristics on smallmouth bass catch in eastern South Dakota lakes; (2) provide a statewide assessment of smallmouth bass population characteristics, and a preliminary assessment of the need for harvest regulations; (3) evaluate the relationship of various physical, chemical, and biological factors to smallmouth bass population characteristics in eastern South Dakota lakes; and (4) provide management recommendations and research needs for smallmouth bass populations in South Dakota waters.

MILLER, N. 1988. Largemouth bass transfers in the Parry Sound District, 1988. File Report. Ontario Ministry of Natural Resources. Parry Sound, Ontario.

A largemouth bass (*Micropterus salmoides*) transfer was conducted in the Parry Sound District from September 11 to 25, 1988. Four hundred and seventy-five (475) largemouth bass, with an average size of 25 cm, were netted from Axe Lake (Monteith Township) and released into 4 recipient lakes in the District. One hundred and one (101) largemouth bass were introduced into Clear Lake (Burton Twp.), 123 into Blackwater Lake (Christie Twp.), 211 into Deer Lake (Lount Twp.), and 40 into Gordon Lake (McKenzie Twp.). It is hoped that these introductions will provide self-sustaining populations and fisheries in the future.

MILLER, R. R. and J. R. ALCORN. 1943. The introduced fishes of Nevada, with a history of their introduction. Transactions of the American Fisheries Society 73 : 173-193.

At least 39 species and subspecies of fishes have been introduced into the waters of Nevada since 1873. Of these, 24 kinds are now known to occur in the state. A thorough survey of the exotic fishes has not been made, but specimens or records of introduced species have been kept in the course of rather extensive collecting of the native fish fauna from 1934 to 1943. Consequently it is believed that the number of introduced species herein enumerated approaches a complete tabulation. Some additions among the sunfishes and catfishes may be necessary.

The northern smallmouth bass (*Micropterus dolomieu dolomieu*) was first stocked in 1888 in Carson River, Washoe Lake, and a private reservoir near Carson City. The attempted introduction was apparently unsuccessful and the species has been mostly replaced by the largemouth bass. The first account of the smallmouth bass in reports of the Nevada Fish Commissioner or the Nevada Fish Commission was for 1913, when 400 were sent to Stone Cabin, Nye County, on August 12, 1911. In this same report "black-bass" are listed in the same column with, but not under, "smallmouth." This may indicate that all black bass in this column are smallmouth. If so, smallmouth bass were planted in the Humnbolt River near Winnemucca and Comins Lake, White Pine County, in October, 1911.

It is not known when the largemouth black bass (*Huro salmoides*) was first introduced into Nevada. There is also evidence that black bass were planted in Washoe Lake and in the Carson River in 1887-1888. These fish were obtained from the Spring Valley Water Company of San Francisco, California. Although black bass were frequently mentioned in the early reports, no mention was made of the species involved. Many persons associate the name black bass with *Micropterus dolomieu*, the smallmouth bass, but after reading reports of the Nevada Fish Commissioner and the Nevada Fish Commission, there appears to be no confusion here. Six hundred were obtained from the California Fish Commission and along with 1,200 adults seined from two ponds near Reno were distributed in Esmerelda, Douglas, Lander, Washoe, Elko, White Pine, Churchill, Humbolt and Lyon counties in 1907 and 1908. Largemouth bass have been abundant in many parts of Nevada since 1910, and perhaps since 1900. During the period 1900-1941, 195,050 eggs and fish were sent by the federal government to Nevada. In the year 1939 alone, 80,000 fingerlings were planted in Lake Mead. In the same year, it was reported that 295 largemouth bass were transferred from the California State Central Valleys Hatchery to the State of Nevada.

This bass is now common in the lower portions of the Walker, Carson, Truckee, and Humbolt rivers. It is known also from the Colorado River in Lake Mead and below Boulder Dam and in Moapa River.

MINISTÈRE DU LOISIR, DE LA CHASSE ET DE LA PÊCHE. 1988. Critères et pratiques d'ensemencement: Resumé et recommendations. Gouvernement du Québec, Ministère du Loisir, de la Chasse et de la Pêche, Direction Générale de la Ressource Faunique. Québec City, Québec.

In the Province of Québec the smallmouth bass is used both for rehabilitative and introductory purposes. It is important that during the first year of planting there be a minimal amount of competition and predation. When there is little risk of predation fry or fingerlings (less than 10 cm in total length) should be stocked at a rate of 100-250 per ha. The fish are stocked according to availability, no matter the season or the strain. When there is a risk of predation only large fingerlings (greater than 10 cm) should be stocked at densities less than 50 fish per ha. For both cases it is recommended that stocking be continuous for at least three consecutive years (after which time an evaluation should be completed) and that the fish always be planted in an area which offers suitable habitat.

MIRANDA, L. E. and W. D. HUBBARD. 1994. Winter survival of age-0 largemouth bass relative to size, predators and shelter. North American Journal of Fisheries Management 14(4) : 790-796.

Winter mortality of age-0 largemouth bass (*Micropterus salmoides*) is sometimes size dependent, with smaller fish experiencing higher mortality. We conducted this study to determine if the presence of predators influenced winter mortality of young largemouth bass, if predators influenced all sizes of young equally, and if increased shelter availability moderated a possible relation between predator-induced mortality and fish size. We stocked 0.06-ha experimental ponds with largemouth bass (30 fish/pond) of five length groups (55-100, 101-125, 126-150, 151-175, and 176-200 mm total length), with and without predators (three largemouth bass 250-350 mm long) and four levels of shelter (0, 10, 16 and 26% brush coverage of surface area of ponds). In ponds without shelter, survival ranged from 10-97% in the presence of predators and from 77-93% in the absence of predators. Fish less than 126 mm long had gradually lower survival in the presence of predators, but near 80% survival in the absence of predators. In ponds with predators and shelter, survival increased with fish length and amount of shelter, but the lifesaving value of increased length and shelter relative to winter survival faded in fish 126 mm or more in length. We suggest that in lower latitudes predators may be a major source of mortality of small age-0 largemouth bass in winter, and that the effects of predators can be tempered by shelter.

MITCHELL, J. M., K. K. SELLERS, W. D. HARVEY and L. T. FRIES. 1991. Effects of stocking regime and harvest regulation on Florida largemouth bass stocking success. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 45 : 477-483.

During a two year period, 25,000 Florida largemouth bass fingerlings were stocked among the endemic northern largemouth bass population of Tradinghouse Creek Reservoir (1985 = 185/ha,1986 = 123/ha). We used electrophoresis to estimate proportions of Florida, northern and Florida x northern intergrade largemouth bass within pre-stocking, stocking year and post-stocking year cohorts. Ages of largemouth bass were determined by examination of whole otoliths. The proportion of Florida phenotypes within the stocking year cohort was not increased when the stocking rate was more than 50/ha or greater. Stocked Florida phenotypes comprised 6% and 25% of the 1985 and 1986 cohorts, respectively, at age 1. Implementing a less restrictive harvest regulation accelerated introgression of the Florida genome by providing size-related, selective harvest of larger, northern largemouth bass. During the two year period from 1987-1989, Florida and Florida x northern phenotypes increased from 22% to 78% of largemouth bass sampled.

MITZNER, L. 1974. Life history and dynamics of largemouth bass in man-made lakes. Dingell-Johnson Project No. F-88-R-1, Job Nos. 1-3, Study 503-1, Annual Performance Report. Iowa Fisheries Commission. Des Moines, Iowa. 26 p.

Life history and population dynamics of largemouth bass in 1971-1973 were determined at Red Haw Lake, Green Valley Lake and Bobwhite Reservoir which are three discrete types of man-made lakes. A lake classification system was defined with reference to the study lakes. Length-weight regressions of bass were similar between populations and years, but condition factor varied from 1.39 at Red Haw in 1971 to 1.75 at Green Valley in 1973. Growth in length and weight was greatest at Green Valley, and by age V bass weighed 24% more than at Red Haw Lake and Bobwhite Reservoir. Total annual mortality at Red Haw Lake was 0.39, and 0.32 at Bobwhite Reservoir. Populations were largest at Red Haw with 1,646 followed by Bobwhite with 369 and Green Valley with 91. Standing stock estimates were 27 kg/ha at Red Haw, 8.2 kg/ha at Bobwhite, and 0.2 kg/ha at Green Valley. As standing stocks increased body condition and growth decreased while total mortality increased. Relative abundance of 0-age largemouth bass at Red Haw and Bobwhite were similar in 1973, while density of young bass at Green Valley was significantly lower. The 0-age bass population increased significantly at Bobwhite while the population remained unchanged at Red Haw by stocking hatchery-reared fingerling largemouth bass at 250 per ha.

MITZNER, L. 1976. Life history and dynamics of largemouth bass in three man-made lakes in Iowa: Contribution of stocked fingerling largemouth bass to the fishery in two man-made lakes. Dingell-Johnson Project No. F-88-R-3, Job No. 3, Study No. 503-5. Iowa State Conservation Commission. Des Moines, Iowa. 4 p.

Catch effort of age-0 bass at Red Haw Lake averaged 25 per seine haul which was significantly greater ($P < 0.01$) than abundance indices from four previous years. Relative abundance of young bass at Bobwhite Lake was lowest since the inception of the investigation in 1971. Hatchery-reared, age-0 bass stocked at Bobwhite Lake in October resulted in a highly significant ($P < 0.01$) increase in seine haul catches of young bass. Age-1 bass which were experimentally stocked the previous year also resulted in significantly ($P < 0.05$) increased relative abundance of the year class.

MITZNER, L. and K. HILL. 1976$_a$. Man-made lakes investigations: Evaluation of the split-stocking method in Iowa farm ponds: Mortality of bluegill and largemouth bass. Dingell-Johnson Project No. F-88-R-3, Job No. 1, Study No. 403-2. Iowa State Conservation Commission. Des Moines, Iowa. 14 p.

Experimental farm ponds were stocked under the split stocking guidelines established in 1974 for the farm pond program. Fish populations in the ponds were investigated to determine mortality of bluegill and largemouth bass by two methods. Two ponds were drainable with actual mortality determined biannually. At the remaining ponds mortality was estimated by the geometric decrease in catch effort values using three types of sampling gear. Electrofishing catch rates of age-1 bluegill ranged from 0 to 176 fish per shocker hour and were greatest in May, July and August, while age-0 largemouth bass catch effort ranged from 0 to 81 fish per shocker hour. Tow net catch effort of young bluegill was highest in August, while seine catch values were greatest in September before declining. Mortality of age-1 bluegill in the drainable ponds was 23 and 80%, while age-0 bass mortality was 40 and 44%. Mortality of 0-age bluegill computed from catch effort statistics in the other ponds ranged from 16 to > 95%, but averaged 63%. Mortality of age-1 bluegill and age-0 bass computed from catch effort values was 60% and 54%, respectively.

MITZNER, L. and K. HILL. 1976$_b$. Man-made lakes investigations: Evaluation of the split-stocking method in Iowa farm ponds: Growth of bluegill and largemouth bass. Dingell-Johnson Project No. F-88-R-3, Job No. 3, Study No. 403-2. Iowa State Conservation Commission. Des Moines, Iowa. 6 p.

Growth of largemouth bass was determined in the same ponds where they were stocked at 250/ha (100/ac) in June, 1976. Mean body length at stocking was 36 mm (1.4 in) which increased to 170 mm (6.7 in) by November. Bluegill growth was slowest at Coffey Pond and most rapid at Adair Pond, while bass growth was slowest at Pierce Pond and greatest at Shelton Pond. Ponds with greater age-0 bluegill abundance had the most rapid bass growth.

MODDE, T. 1980. State stocking policies for small warmwater impoundments. Fisheries 5(5) : 13-17.

The results of a nationwide survey of state agency warmwater pond stocking policies are reported. As expected, a high degree of variability among recommendations was observed. The greatest similarity in species recommendations was seen in the southeastern states where a combination of the largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*), and redear sunfish (*L. microlophus*) was employed most often. Although stocking rates for largemouth bass were rather uniform, considerable variation was observed among rates for sunfish. Use of the alternate year stocking method was recommended by 66.7% of the state agencies utilizing the bass-sunfish combination. Geographical trends in stocking recommendations suggested that although the bass-bluegill combination may be successful in the southern and midaltitudes of the United States, alternative combinations may be preferable in northern latitudes.

MODDE, T. C. 1982. Largemouths in farm ponds – can't fool our local bass with a southern stocking formula. South Dakota Farm 33 : 19-21.

MODDE, T., D. GALBRAITH and J. C. YOUNG. 1986. Influence of predatory-prey relationships upon stocking strategies for largemouth bass and bluegill in small northern impoundments. American Fisheries Society Annual Meeting 116 : 31. (Abstract only)

MODDE, T. and C. C. STONE. 1980. Growth and biomass of largemouth bass (*Micropterus salmoides*) in a western South Dakota stock pond. Proceedings of the South Dakota Academy of Science 59 : 138-146.

MOEN, T. 1960. Survival of stocked smallmouth bass in Iowa natural lakes. Iowa Fish and Game Division Quarterly Biological Reports 12(4) : 5-10.

MOFFETT, J. W. 1943. A preliminary report on the fishery of Lake Mead. Transactions of the North American Wildlife Conference 8 : 179-186.

Lake Mead was created by the construction of the Boulder Dam and has, since its inception, supplied sportfishing opportunities. The largemouth bass was introduced and quickly became the most sought after species in the lake. From 1935 to 1940, the bass fishery was thriving and then quite suddenly experienced a decline in 1941. The fish were found to be thinning and had lost their gameness. Studies conducted in 1941 demonstrate that spawning conditions for the bass and bluegill (their main prey) are satisfactory and the 1941 spawning season for largemouth bass was highly successful. It is recommended that at this time no additional stocking should take place and the introduction of smallmouth bass is inadvisable while there are still large numbers of largemouth bass present.

MONROE, B. P. and F. J. HICKS. 1985. Smoke Lake data summary. Algonquin Fisheries Assessment Unit. File Report. Ontario Ministry of Natural Resources. Whitney, Ontario. 13 p. + tables.

It is unknown exactly when smallmouth bass were first introduced to Smoke Lake, however it is speculated that they made their first appearance around the turn of the century.

MOORMAN, R. B. 1956. Some factors related to success of fish populations in Iowa farm ponds. Transactions of the American Fisheries Society 86 : 361-370.

Minnow seines and larger bag seines were used to determine the reproductive success of fish in all (60) farm ponds known to have been stocked with fish in Marion County, Iowa. Additional data on lengths, weights, ages, and abundance of the fish were collected from many of the ponds. Ponds smaller than 0.5 acre were less successful than larger ponds. Fifteen of the 26 ponds stocked with the bass-bluegill-bullhead combination were successful. The rates of stocking within the range of 300 to 1,000 bluegills per acre in combination with bass had little influence on success or failure of fish ponds. Pond management practices by the farm operator were generally limited to fencing for exclusion of livestock. The ponds were not heavily fished, and harvest did not exceed 65 pounds of fish per acre per year at the most heavily fished ponds. Clay turbidity probably delayed growth of bass. Aquatic vegetation was not important in determining success of fish populations. Winterkill occurred one or more times in the fish populations of 31 of the 60 ponds.

MORGAN, G. D. 1958. A study of six different pond stocking ratios of largemouth bass (*Micropterus salmoides*) and bluegill (*Lepomis macrochirus*) and the relation of the chemical, physical and biological data to pond balance and productivity. Journal of the Scientific Laboratory of Denison University 44(11) : 151-202.

MORGAN, G. D. 1960. A study of the effects of fertilizers on vegetation growth, plankton population and numbers, and pounds of bass harvested – in eight one-acre ponds. Journal of the Scientific Laboratory of Dension University 45 : 3-17.

MORIZOT, D. C., J. H. WILLIAMSON and G. J. CARMICHAEL. 1988. Hybridization among native and introduced *Micropterus* spp. in central Texas. Presented at the Annual Meeting of the American Fisheries Society 118 : 79. (Abstract only)

Allozyme variants in black basses were used to assess hybridization in the Blanco, Llano and San Marcos rivers in central Texas. Native basses examined included Guadalupe bass (*Micropterus treculi*), spotted bass (*M. punctulatus*) and northern largemouth bass (*M. salmoides salmoides*); introduced forms included

Florida largemouth bass (*M. s. floridanus*) and smallmouth bass (*M. dolomieui*). At least 21 enzyme loci exhibited polymorphisms within or among species, allowing precise characterization of hybrid individuals from natural populations. Results from different rivers indicated strikingly different prevalence rates of hybridization. In the Llano River, only largemouth bass and Guadalupe bass were present, with no detectable interspecific hybrids collected. In the Blanco River, by contrast, largemouth (Florida and northern), smallmouth and Guadalupe bass genes were detectable in a variety of complex hybrids reflecting a minimum of three generations of interspecific hybridization. Guadalupe x smallmouth bass hybrids produced reciprocal backcross hybrid types, and largemouth x Guadalupe bass hybrids beyond the first filial generation were observed. These data suggest that introduction of smallmouth bass into native bass populations in central Texas at least sometimes results in massive breakdown of reproductive isolation. The large number of species-specific allozyme markers allows accurate inferences of mating patterns resulting in complex hybrid-derived genomes.

MORIZOT, D. C., S. W. CALHOUN, L. L. CLEPPER, M. E. SCHMIDT, J. H. WILLIAMSON and G. J. CARMICHAEL. 1991. Multispecies hybridization among native and introduced centrarchid basses in central Texas. Transactions of the American Fisheries Society 120 : 283-289.

Allele frequency differences at 11 polymorphic protein loci provided discrete genetic markers with which to estimate the extent of hybridization among native and introduced centrarchid basses in central Texas streams. Native Guadalupe bass (*Micropterus treculi*) and northern largemouth bass (*M. salmoides salmoides*) now coexist with introduced Florida largemouth bass (*M. s. floridanus*) and smallmouth bass (*M. dolomieu*) in these streams. Interspecific hybridization was detected in three of four populations from the Blanco and San Marcos rivers, hybrids making up at least 31.8% of the individuals sampled. Complex hybridization patterns were evident because F_1, F_2, and backcross hybrids were detected. At least one individual exhibited genetic markers of largemouth, smallmouth and Guadalupe bass. Extensive multispecies hybridization threatens the survival of the endemic Guadalupe bass.

MOSINDY, T. 1998. Lake of the Woods bass fishery: A case study. Northwest Science and Technology, NWST Technical Report TR-115. 12 p.

The largemouth and smallmouth bass are both introduced species to Lake of the Woods. Smallmouth bass were first introduced to Longbow Lake in 1903 and it is suspected that some of these fish escaped into Lake of the Woods. By the late 1930s there were established smallmouth bass populations in both the Anulneau Peninsula and Whitefish Bay. Lake of the Woods became well known for its smallmouth bass and was used as a donor lake for bass transfers. Between 1945 and 1952 at least 1,000 adult bass and fry were removed yearly and transferred to waters in the Kenora District. The Minnesota Department of Conservation initially stocked largemouth bass into the lake in 1925 and later in 1931. These first plantings were unsuccessful and until the mid-1960s to early 1970s no fish were returned to the angler. It is thought that these largemouths were the result of unauthorized introductions into nearby Wigwam and Dogpaw lakes between 1940 and 1950.

MOYLE, P. B. and N. J. HOLZHAUSER. 1978. Effects of the introduction of Mississippi silverside (Menidia audens) and Florida largemouth bass (*Micropterus salmoides floridanus*) on the feeding habits of young-of-year largemouth bass in Clear Lake, California. Transactions of the American Fisheries Society 107(4) : 574-582.

Young-of-the-year largemouth bass in Clear Lake, California, switched from feeding largely on bluegill (*Lepomis macrochirus*) to feeding largely on Mississippi silverside or on a mixture of prey species following the establishment of the silverside in the lake in 1967. Choice of prey, however, was influenced by the relative abundance of the prey, the habitat occupied by the bass, time of day, and size of bass. The bass usually switched to a predominantly fish diet at a smaller size when silversides were the main prey than when bluegill or Sacramento blackfish (Orthodon microlepidotus) were the main prey. The success of the introduction of small numbers of Florida largemouth bass into the lake in 1969-71 was demonstrated by the presence of significant numbers of bass that could be classified as intergrades between Florida and northern largemouth bass (*M. s. salmoides*), the subspecies originally introduced into Clear Lake. No meaningful differences in the feeding habits or average lengths of the intergrades and "pure" northern bass were found.

MRAZ, D. 1954. Carp vs. largemouth bass. Wisconsin Conservation Bulletin 19(4) : 18-19.

Many believe that carp are responsible for the decrease in numbers of largemouth bass. To observe the effects that carp have on largemouth bass four ponds were stocked with combinations of bluegills, crappies, carp and largemouth bass. Certain stocking ratios were used: 200 pounds of carp per acre and 200 ponds of gamefish per acre (40 pounds of bass, 60 pounds of bluegills, and 100 pounds of crappies). All of the fish stocked were adults.

In the pond with carp only the turbidity of the water was so high that the daylight could only penetrate half the depth which it did prior to stocking. In a pond with bass, crappies and bluegills the water did not become turbid.

Carp appeared to have an effect on the spawning of the largemouth bass. When both species were together, largemouth bass spawned in areas which were atypical. Instead of spawning along the rocky banks the bass chose to spawn in the center of the ponds, areas which were relatively undisturbed by the carp. In the absence of carp, in a pond with only bluegills and largemouth bass, the bass resumed their use of their regular spawning sites. Although, bass reproduction was much lower when exposed to carp it is important to note that the carp did not prohibit the bass from spawning.

MRAZ, D. 1964. Observations on large and smallmouth bass nesting and early life history. Research Report No. 11. Wisconsin Conservation Department. Madison, Wisconsin. 13 p.

This report has been used as a template to present data accumulated over the past ten years concerning the spawning habits and initial life stages of largemouth (*Micropterus salmoides*) and smallmouth (*M. dolomieui*) bass which was outside the scope of the original research project. Observations were made concerning the techniques used to locate spawning nests, the marking of the nests, and the sampling of the nests as well as examinations of the growth stages of the young fish (egg to fry). Most relevant are the guidelines which direct the planting of largemouth bass in ponds.

Waukesha County leads the state of Wisconsin in the number of ponds available for stocking. I have recommended that in ponds less than one surface acre in size only two to three pairs of adult bass be stocked, and in ponds one to two acres in size three to five pairs be stocked (not usually to exceed two pairs per acre). If planted pre-spawning only this small number of bass is needed, as each nest can produce up to 5,000 fingerlings. These rates are not used consistently throughout the county. In one instance a pond owner stocked 15 adult bass in the spring of 1957, and in October 1959 a single seine haul resulted in the capture of 688 bass between 5 to 9 inches long. These fish were then used for rehabilitative purposes in other lakes. Unfortunately, when such a great number of fish are planted initially, the population tends to stunt, as happened in this case.

MRAZ, D. and E. L. COOPER. 1957. Introduction of carp, largemouth bass, bluegills, and black crappies in small rearing ponds. Journal of Wildlife Management 21 : 127-133.

The present study was designed to determine the success of natural reproduction and early survival of carp, largemouth bass, bluegills, and black crappies in small ponds with mixed populations of mature fish at known densities in southern Wisconsin.

Adult fishes were stocked in ponds in April or May, and the ponds were drained in September or October. During this period, the percentage survival of adult carp far exceeded that of the other species, as follows: carp, 95.9; largemouth bass, 49.5; bluegills, 35.8; and black crappies, 44.0.

There was little apparent correlation between the number of brood fish stocked in the ponds and the strength of the resulting year class. There was also little consistency in the success of natural reproduction of a particular species from one year to the next when the same combination of species was used to stock the ponds. The range in standing crop of the young of each species during the three-year period, expressed as the number of fish per acre, was very great: carp 7 to 6,340; largemouth bass 0 to 12,305; bluegills, 494 to 13,560; and black crappies, 0 to 503.

MULFORD, C. J. 1984. Statewide fisheries research: Florida largemouth bass stocking evaluation. Dingell-Johnson Project F-31-R-10, Job No. XXVII. Texas Parks and Wildlife Department. Austin, Texas. 38 p.

MUNCY, R. J. 1966. Aging and growth of largemouth bass, bluegill and redear sunfish from Louisiana ponds of known stocking history. Proceedings of the Annual Conference of Southeastern Association of Game and Fish Commissioners 19(1965) : 343-349.

Scales of largemouth bass taken from two ponds at Baton Rouge, Louisiana over a three year period agreed closely with the known past stocking history on these fish. Largemouth bass scales from a 50 acre pond at Clinton, Louisiana indicated agreement with the six years fish had been stocked. Total length growth rates of bass were increased by controlled fall drawdown; however prolonged summer droughts decreased total length growth and condition factors. Spawning and drastic drawdowns resulted in more pronounced growth checks than winter cessation on the scales of bluegill and redear sunfish from ponds of known stocking history.

MUSCHETT, M. 1999. Southcentral region aquaculture licences (culture and sell and fishing preserves), breakdown by administration area or district. Data summary. Ontario Ministry of Natural Resources, Fish Culture Section. Peterborough, Ontario. 9 p.

NAIL, M. L. and D. H. POWELL. 1975. Observations on supplemental feeding of a 75 acre lake stocked with largemouth bass, bluegill, redear and channel catfish. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 28 : 378-384.

Barbour County Public Fishing Lake (75 acres) was stocked with approximately 500 channel catfish per acre in combination with the normal stocking rates of largemouth bass, bluegill and redear sunfish. The lake was supplementally fed on one side only, in addition to receiving a regular fertilization program.

At the end of one year of fishing, 305.5 fishermen per acre had harvested 621.8 pounds of fish per acre. Of this total, bluegill comprised 381 pounds per acre.

There was no significant difference between the weights of bluegill collected from the fed and non-fed areas. There was a significant difference between the weight of bluegill collected shortly after the feeding program was initiated and bluegill collected 14 months later. Bluegill from Barbour County Public Fishing Lake were significantly heavier for a given length as compared to the bluegill of three public lakes.

NEAL, J. W., R. L. NOBLE and T. N. CHURCHILL. 2000. Timing of largemouth bass supplemental stocking in a tropical reservoir: Impacts on growth and survival. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

We examined the growth, survival, and contribution of microtagged largemouth bass during four supplemental stocking events. Fingerling largemouth bass were stocked at 25 fish/ha into (spring) and outside of (off-season) wild juvenile cohorts. Intensive recapture efforts 1 month after stocking revealed effects on growth and survival that were related to size distribution and abundance of wild-spawned juvenile largemouth bass. Initial growth rates ranged 0.63-1.50 mm/day, and were negatively correlated to wild juvenile abundance and positively correlated to differences in mean length of wild and stocked juveniles. Growth was rapid to 275 mm TL, and then decreased sharply to around 0.20 mm/day for both spring and off-season stockings. Growth was undetectable by age 2. Daily mortality rates ranged 0.00224 to 0.01085 and were generally lower for off-season stockings. Stocked largemouth bass contributed directly to the stock at age 1 and age 2, but most had disappeared by age 3, consistent with an overall population size structure characteristic of a short-lived population. This truncated size and age structure demonstrated the importance of sustained recruitment, which can be significantly facilitated using supplemental stocking in years of small wild cohorts. We concluded that supplemental stocking should be performed during off-season periods (September-November), i.e., maximizing the time between previous and future spawning events.

NEWBURG, H. J. 1975. Statewide fisheries research: Review of selected literature on largemouth bass life, history, ecology and management. Investigational Report 335. Minnesota Division of Fish and Wildlife. St. Paul, Minnesota. 78 p.

NEY, J. J., R. S. HOOVER and E. M. HALLERMAN. 1991. Evaluation of the performance of stocked Florida and northern largemouth bass and their progeny in Briery Creek Lake, Virginia. Dingell-Johnson Project VA F-96-R-1 and F-96-R-2, Job Nos. 1&2, Final Report. Virginia Department of Game and Inland Fisheries. Richmond, Virginia. 57 p.

Fingerling Florida (*Micropterus salmoides floridanus*) and northern largemouth bass (*M. s. salmoides*) were stocked in Briery Creek Lake in 1986 and 1987. Bass were collected by electroshocking in the autumn of 1989 and 1990 and spring of 1990 and 1991 to evaluate the performance of the subspecies and their progeny.

NIEMAN, D. A. and M. D. CLADY. 1978. Florida largemouth bass investigations: Boomer Lake investigation. Dingell-Johnson Project OK F-33-R, Job No. 1, Final Report. Oklahoma Cooperative Fishery Research Unit. Stillwater, Oklahoma. 107 p.

The introduction of Florida largemouth bass into Boomer Lake was unsuccessful. This largemouth bass subspecies has experienced high survival in another, non-heated, Oklahoma reservoir. A comparison of the northern and Florida largemouth bass was also completed.

NOBLE, R. L. 2000. Reflections on 25 years of progress in black bass management. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

Management of fisheries for black basses continues to focus on largemouth, smallmouth, and spotted bass. Despite the dual role of black bass as targets for directed fisheries and as important fish community components, agencies continue to manage black bass in public waters with priority on fishery objectives. Management is increasingly being conducted under management plans that incorporate broader system considerations. Black bass in private impoundments, increasingly being managed by consultants, are managed as integral parts of the predator-prey system. Expansion in competitive fishing for black bass and the associated organization of black bass anglers have created new demands. Harvest regulations continue to be the principal fishery management approach of agencies; regulations are used increasingly to structure size/age distributions, but adoption of catch/release ethics has compromised their effectiveness. Florida largemouth bass have been introduced successfully to provide trophy benefits outside their range; otherwise stocking generally has become more attentive to genetic integrity of black bass stocks and species. Habitat enhancement has occurred primarily through the implementation of general clean water legislation. Standardization of assessment protocols has improved agency-wide management efforts. New emphases on biodiversity and ecosystem management should make future black bass management more inclusive.

NORGREN, K. G., R. A. DUNHAM, R. O. SMITHERMAN and W. C. REEVES. 1988. Biochemical genetics of largemouth bass in Alabama. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 40(1986) : 194-205.

Thirty-six enzyme loci were surveyed for 22 largemouth bass (*Micropterus salmoides*) populations from 7 watersheds in Alabama. Twenty-one loci were polymorphic. Nei's normalized genetic identity (I) and Rogers' genetic similarity (S) showed little divergence among the populations ($I = 0.990$ and $S = 0.9792$). However, several drainages contained unique alleles in frequencies greater than 0.05 and several alleles were identified that were not found in a previous nationwide survey. Significant intrapopulational heterogeneity was indicated by hierarchical F-statistics and contingency chi-square analysis. Clinal distribution of MDH-B alleles significantly affected populational differentiation. Allelic variation at MDH, AAT and IDH loci accounted for 82% of the total population differences. Variability of largemouth bass populations differed among the physiographic regions of Alabama. Frequencies of alleles from the Florida subspecies, *M. s. floridanus*, were increased through supplemental stocking programs in Alabama.

NOVINGER, G. 1980. A comparison of the simultaneous and split methods of stocking largemouth bass and bluegills in ponds. Dingell-Johnson Federal Aid Project MO F-1-R-28, Study I-21. Missouri Department of Conservation. Jefferson City, Missouri.

O'BARA, C. J. and J. CRUNK. 1998. A review of warmwater stream fisheries management in the southeastern United States. Presented at the 1998 Southern Division of the American Fisheries Society mid-year Meeting. Lexington, Kentucky. (Abstract only)

Warmwater streams and rivers provided anglers ample opportunities to enjoy fishing in a diverse setting. Southeastern streams and rivers are inhabited by a wide range of sportfish including the sunfishes, black basses, catfishes, true basses, and percids. Fishery management programs vary as much as potential fisheries. Although novel to most states, management techniques to enhance warmwater lotic fisheries are becoming more widespread. A review of southeastern state's programs will be provided including regulations, stocking, and habitat enhancements.

O'BARA, C. J., C. DRUMRIGHT, B. WILSON, D. RIZZUTO, D. PETERSON and J. NEGUS. 1997. Supplemental stocking of white crappies and largemouth bass in two impoundments. Presented at the 1997 Southern Division of the American Fisheries Society mid-year Meeting. San Antonio, Texas. (Abstract only)

Recently, supplemental stocking of warmwater sportfish has become popular with fish and wildlife agencies because of increased angling pressure and the public's perception that stocking of more fish will always improve angling. White crappie (*Pomoxis annularis*) and largemouth bass (*Micropterus salmoides*) were introduced into two systems in an effort to enhance these important recreational fisheries. Both species were implanted with micro-wire tags prior to release. Two week post tagging survival exceeded 95% for both species. Approximately 9,000 hatchery-reared tagged white crappie (100-150 mm in TL) were released into Herb Parsons Lake, a small highly-managed impoundment, in January 1994. A full-time complete creel survey was conducted beginning in the Spring 1994 with clerks instructed to determine the presence of micro-tags using a hand-held wand. Fewer than 100 micro-tagged white crappie have been harvested by anglers. Collections by trap nets and gill nets also have produced few tagged white crappie although naturally produced white crappie of the 1993 year class were well represented. Nine thousand tagged largemouth bass were introduced into two embayments of Norris Reservoir in October 1995. These fish (120-200 mm) were reared in a nursery pond adjacent to the reservoir. Attempts by electrofishing in the fall 1995, spring 1996, and fall 1996 have failed to produce a single tagged individual. The 1995 year class was represented in all samples. The stocking of white crappie and largemouth bass into systems with natural reproduction appears to be counter-productive. It appears that better education of the angling public concerning supplemental stocking may be more rewarding to both the angler and agencies.

ODELL, T. T. and W. C. SENNING. 1937. Lakes and ponds of the lower Hudson area. p. 104-123 *In* A Biological Survey of the Lower Hudson Watershed. Supplemental to the 26th Annual Report, 1936. State of New York Conservation Department. Albany, New York.

The more important ponds and lakes are discussed with particular reference to the physical, chemical, biological and historical data relating to fish production. Tabulations summarize miscellaneous data for the larger bodies of water and estimates of the relative abundance of fishes in these waters. Information especially pertinent relates to the reasonings behind many of the smallmouth and largemouth black bass stockings. In many lakes the introduction of largemouth bass is done to reduce the number of carp in the system, such as at Triangle Lake, Stissing Pond and Lake Katrine. The other most common reason for stocking both largemouth and smallmouth bass, other than purely for angling purposes, was to supplement a heavily parasitized natural population. These populations were thought to be diseased to the extent that natural reproduction was inhibited.

OLIVER, J. D., G. F. HOLETON and K. E. CHUA. 1979. Overwinter mortality of fingerling smallmouth bass in relation to size, relative energy stores and environmental temperature. Transactions of the American Fisheries Society 108(2) : 130-136.

Hatchery-reared, age-0+ smallmouth bass (*Micropterus dolomieui*) of 55-107 mm total length were wintered from September 1975 to May 1976. Temperature regimes were modeled on those of the natural environment and final temperatures were 2,4, and 6°C. Final wintering temperature did not noticeably influence mortality rates. Long fish survived the period of low temperature better than did shorter ones. Body ratios of dry weight/wet weight, lipid weight/dry weight and ignitable weight/dry weight all decreased during wintering, and the data indicated that there may be critical percentages of dry weight/wet weight and ignitable weight/dry weight below which these fish will die

ONTARIO MINISTRY OF NATURAL RESOURCES. 1976. Guidelines for stocking of hatchery fish: Draft policy. Ontario Ministry of Natural Resources. Toronto, Ontario. 20 p.

The purpose of this report is to present for discussion draft guidelines for fish stocking which can then be customized into a new statement of Ministry policy. Currently the stocking of warmwater species is second to that of the coldwater variety. Small and largemouth bass, maskinonge and yellow pickerel now are cultured on a limited basis. In the past many introductions of these species have taken place, sometimes successfully. Unfortunately, the success of the new species may come at the expense of native fish. Some introductions are associated with the collapse of salmonid communities and other incidences have caused the introduced species to develop a large, but stunted population. Typically, further stockings of these species are unnecessary with the exception of specific attempts at rehabilitation. If the stocking of smallmouth and largemouth bass is necessary it is important to stock these species under the proper conditions to enhance chances of survival. Through experimentation it has been found that the preferred temperature of largemouth bass is 27°C, while that of smallmouth bass is 21°C. In order to minimize the amount of stocking stress experienced by the fish the temperature of the water into which the bass are stocked should not exceed 32°C and 30°C, respectively.

ONTARIO MINISTRY OF NATURAL RESOURCES. 1982. General policy for stocking fish in Ontario. Ontario Ministry of Natural Resources. Fisheries Branch, Fish Culture Section. Toronto, Ontario. 14 p.

In the past non-salmonids and coregonines were usually stocked as fry because of the difficulty in rearing them past this stage. Fry introductions of warmwater fish, with the exception of walleye fry or fish into empty waters, have been unsuccessful at supplying fishing opportunities. Presently smallmouth bass are stocked only on a limited basis because of the damage inflicted upon salmonid communities upon their introduction. This species is currently only stocked in areas where reproduction of wild fish is extremely low or non-existent.

ONTARIO MINISTRY OF NATURAL RESOURCES. 1989. Guidelines for smallmouth bass introductions in the Northern Region. Ontario Ministry of Natural Resources. Cochrane, Ontario. 7 p.

Until the early 1900s smallmouth bass were unknown in Northern Ontario. Since then smallmouth bass have been introduced to Gogama, Kirkland Lake and Chapleau, along with smaller-scale introductions in Hearst, Cochrane and Kapuskasing. The stocking of smallmouth bass in the northern region has allowed for a relent on the fishing pressure of other game fish and provides a wider diversity of angling opportunities.

The introduction of a new species can possibly have negative impacts on the environment upon its entering, so it is imperative that thorough research be conducted prior to any introductions.

With regards to policy, all new introductions must meet the criteria of the Field Environmental Planning Procedure (F. E. P. P.) for the approved Class E. A. for Fish Stocking in New Waters. It is important to recall that fish stocking is not always successful and periodic re-stocking may be required, this is especially true of multi-species lakes, where smallmouth bass introductions have shown variable results.

Although many past introductions have been improperly evaluated, there has emerged certain trends which can predict the success of an introduction, these being primarily the characteristics of recipient lakes:

- Area – lakes which tend to be smaller and reach high temperatures quickly in the summer are preferred to encourage fast growth of young-of-the-year fish. Small, interconnecting lakes may be adequate.
- Bathymetry – lakes should be relatively shallow with large littoral zones, although there has been some success in lakes greater than 7 m deep.

- Shoreline and Substrate – irregular shorelines are preferred, along with the presence of islands and various types of substrate.
- Water Level – in water bodies controlled by dams, water movement must be minimal during spawning time (May to June).
- Oxygen – fish abundance is typically greatest at levels exceeding 3.0 mg/l.
- pH and Alkalinity – to insure young of year survival, the pH should be between 6-9 and the alkalinity greater than 10 mg/l (must have adequate buffering capacity).
- Trophic Status – eutrophic to mesotrophic waters are preferred, however, there has been limited success in some oligotrophic waters.
- Forage Species – crayfish, small fish and insects should be present along with frogs and some plant material. In the instance where forage is lacking, it is appropriate to stock crayfish or leeches 1-2 years prior to stocking the smallmouth bass.
- Competition – Bass should never be stocked with salmonids, with the exception, perhaps, of lake trout. The presence of other predator species such as yellow perch, northern pike, walleye and sauger should be noted. Some cases of smallmouth bass introduction have demonstrated the tendency of the bass to displace the walleye population and this should be a consideration factor when planting smallmouth bass.

The actual stocking of the smallmouth bass must take into account the origin of the fish and the rates at which they should be stocked in their new environment. To maintain variability, it is essential to rotate the donor stocks each year. When stocking fish into lakes greater than 5,000 ha it can also be beneficial to stock the surrounding watershed which drains into it. Fry stocking has been successful in some areas, however the time to creel and long term survival of the fish must be considered. Studies have shown that smallmouth bass less than 25 cm have high survival levels during transport and adapt easily to new environments. The following are minimal recommended stocking rates for the success of a smallmouth bass introduction:

- Fry – should be planted at a rate of 100 fry/ha
- Juveniles and Adults in lakes 50-450 ha – 100-150 in total
- Juveniles and Adults in lakes > 450 ha – 1 fish for every 3 ha

It is essential that prior to introducing fish from another lake, they be checked for parasites and disease.

Following the introduction of smallmouth bass monitoring is needed to evaluate the success of the plant. A successful transfer should yield a lake identical to one with a natural, healthy smallmouth bass population within 8 to 10 years. Also, the success of a fry introduction can be established through seining and snorkeling in 2-3 years, and reproductive success confirmed 5 to 7 years following the initial stocking.

ONTARIO MINISTRY OF NATURAL RESOURCES. 2000. History of fish culture. p. 2-1 to 2-5 *In* Fish Culture Course 2000 Manual. Course held at the University of Guelph, August 14-18, 2000. Guelph, Ontario.

This section briefly summarizes the worldwide history of fish culture and specifically deals with that in Canada and Ontario. Black bass have been propagated at seven provincial and federal hatcheries since 1872.

PAGE, G. S. 1880. Black bass planting. Transactions of the American Fisheries Society 9 : 58-62.

The results of the introduction of the black bass into Maine waters by the author in 1869 were presented at the Ninth Annual Meeting of the American Fisheries Society.

In 1869, 35 black bass were captured from the private pond of Walter Brown, Esq., in Newburg. The fish were all estimated to be between one-half and one pound. The fish were then transported back to Maine where they were planted. Sixteen of the bass were stocked into the Crochnewaga Pond at Monmouth, Maine and the rest into the Cobbosseecontee Pond at Winthrop. The latter pond is actually connected to a series of water bodies which stretch over 20 miles.

Ten years following the introduction of 35 black bass the results are astounding. Currently, there are 50 ponds in the State which supply good bass fishing. There are negative effects, however. The number of pickerel has been reduced drastically and as a consequence the effort has been made to prohibit the introduction of the black bass into waters occupied by trout.

PALACHEK, K. E. K. 1984. An evaluation of Florida largemouth bass introductions into selected Texas reservoirs. M. Sc. Thesis, Texas A&M University. College Station, Texas.

PANEK, F. M. 1978. Effects of predator stocking on a largemouth bass-bluegill pond fishery. Florida Science 41(4) : 252-255.

PARAGAMIAN, V. L. 1976$_a$. Evaluation of the 14-inch size limit on largemouth bass at Big Creek Lake: Evaluation of a 14-inch minimum length limit on largemouth bass. Dingell-Johnson Project No. F-88-R-3, Job No. 1, Study No. 601-3. Iowa Conservation Commission. Des Moines, Iowa. 20 p.

Big Creek Lake, a recent man-made impoundment, was elected for investigation of an experimental 14-inch size limit on largemouth bass. This lake was recently stocked with bass, bluegill, black crappie and many other sport species and it is expected to have high fishing pressure.

Adult fish populations were sampled monthly with pound nets, experimental gill nets and a 230 volt A. C. electroshocker while an expandable sport fishery survey was conducted from April through August to determine the effects of a 14-inch size limit to control the harvest of bass; vital statistics of bass and related species; species composition; relative abundance; and harvest at Big Creek Lake. Net catches accounted for 6,450 fish weighing 1,510 kg. Black crappie dominated the total catch comprising 62%, white sucker was second, 19%; followed by bluegill, 7%; walleye, 4%; channel catfish, 2%; and bullhead, 2%. Although stocked sportfish dominated the numerical catch, over 52% of the biomass was white sucker and carp. FND catches between pound and experimental gill nets differed for most species, with neither gear effective in taking bass, of three age groups, during the spring while 218 bass were sampled for seasonal growth in the autumn. Average back-calculated lengths were 146, 246, and 331 mm for ages I through III. Growth of all age groups was better in 1975 than for 1974 however, seasonal growth calculations of age-I bass was obviated because they were so poorly represented. Legal sized bass accounted for 9% of the spring electrofishing catch and less than 6% of the autumn sample. A Schnabel population estimate yielded 19,425 bass, ages I through III, for a density of 56 bass/ha or 12 kg/ha, all three categories were the lowest recorded in three years of study. The sport fishery catch of 65,590 fish was dominated by stocked species for the first time. Black crappie predominated, 49,207 fish; bluegill was second, 9,841; followed by largemouth bass, 1,903; walleye, 1,706; and bullhead, 1,575. Anglers creeled an estimated 122 marked age III bass of 644 at large for an estimated exploitation rate of 195. The 1972 largemouth bass year class continued to support the legal fishery. For the third consecutive season the size limit prevented an overharvest of bass when anglers caught and released over 64,000 sublegal bass for a catch rate of 0.45 bass/hr.

PARAGAMIAN, V. L. 1976$_b$. Effects of flood water management and fish species introductions on fish populations in large reservoirs: Vital statistics of fish populations in Lake Red Rock and Lake Rathbun following initial impoundment.

Dingell-Johnson Project No. F-88-R-3, Job No. 1, Study No. 702-4. Iowa Conservation Commission. Des Moines, Iowa. 32 p.

Fish populations were sampled monthly by pound net, experimental gill net and seine net to determine relative abundance, species composition, reproductive success, age structure and vital statistics of important species. At Lake Red Rock 8,565 fish weighing 2,827 kg were caught by pound and experimental gill net. River carpsucker dominated the numerical catch by comprising 26% of the total followed by carp, 22%; crappie, 20% and bullhead, 11%. A major portion of the biomass consisted of river carpsucker, 33%, followed by carp, 21%; crappie, 18%, and northern pike and bigmouth buffalo both at 6%. Stocked fish including largemouth bass, walleye and northern pike decreased in relative abundance from previous years and contributed less than 5% of the total numerical catch. A commercial fishery at Lake Red Rock was responsible for the harvest of over 469,000 kg of fish and reduced mean weights of bigmouth buffalo and carp. Seine hauls captured 1,633 young of 16 species and 0-age and adult Cyprinids. Native 0-age largemouth bass, walleye and northern pike were captured but supplemental stocking of these species seems necessary to maintain the populations. At Lake Rathbun test netting captured 6,390 fish weighing 1,808 kg. The total numerical catch was dominated by crappie, 37%, followed by carp, 27%; white bass, 10%; and bullhead, 10%. Carp contributed over 45% of the weight and crappies 25%. Stockings of fish at Lake Rathbun made an initial impact early in the reservoir's history but have not made a positive change since. White bass has increased substantially in relative abundance but is the only exception. Seine hauls captured 3,115 0-age fish of 11 species and young and adult Cyprinids. Gizzard shad contributed 85% of the seine catch. Vital statistics of important species at each lake are presented.

PARAGAMIAN, V. L. 1977. Fish population development in two Iowa flood control reservoirs and the impact of fish stocking and floodwater management. Technical Series No. 77-1. Iowa Conservation Commission, Iowa Fisheries Research. Des Moines, Iowa. 59 p.

Fish populations in lakes Red Rock and Rathbun were studied after impoundment by monitoring relative abundance, species composition, size distribution, age structure, reproductive success, growth, and stocking success. In addition, reservoir operations were recorded to determine its impact. Adult fish were sampled with four trap-nets and one experimental gill net from April through October, 1972-1975, while young fish and forage species were sampled with a seine net during 10 biweekly intervals each year. Lake Red Rock is characterized by extreme variations in water levels while Lake Rathbun is relatively stable. Fish species suited to river type habitat developed more extensively at Lake Red Rock than at Lake Rathbun. River carpsucker, carp, bullhead, and crappie dominated the fishery at Lake Red Rock while crappie and carp were the most important fish species inhabiting Lake Rathbun. Analysis of variance testing showed no significant change in the species composition of either reservoir; however, catch success within species varied and was dependent on year class success and stockings. Walleye, northern pike, largemouth bass, white bass, channel catfish, and muskellunge were stocked at varying rates, sizes and intervals at one or both reservoirs. Strong year classes of bluegill, crappie, and largemouth bass were recorded at Lake Rathbun in 1973, a year of high reservoir elevation, as were bass and bullhead at Lake Red Rock. High water at Lake Red Rock in 1974 was beneficial to white bass, crappie and bigmouth buffalo. Fish stocking was important in establishment and maintenance of many fish species. Suggested stocking rates are: 2,500 larval walleye/ha (1,000/ac), 2,500 larval northern pike/ha, and 250 postlarval largemouth bass/ha (100/ac). Further consideration should be given to stocking at periods of high zooplankton populations and releases of fish of a larger size to insure higher survival. In general, growth of most species was best during the first few years of impoundment, in later years growth was influenced by storage volume and water quality. Recommendations for reservoir management were presented and included shoreline stabilization, stocking guidelines, habitat improvement, commercial fishing, increased conservation pool elevation and fish population assessment.

PARDEW, M. G. 1992. Dispersal of stocked young of the year smallmouth bass (*Micropterus dolomieu*) in Beaver Reservoir, Northwest Arkansas in 1990. M. Sc. Thesis, University of Arkansas. Fayetteville, Arkansas. 37 p.

PARDUE, G. B. and F. E. HESTER. 1966. Variation in the growth rate of known-age largemouth bass (*Micropterus salmoides*) under experimental conditions. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 20 : 300-310.

Experiments were conducted in three ponds and nine plastic swimming pools to determine the variation in growth rate of largemouth bass (*Micropterus salmoides*) during their first year of life.

Known-age fish were obtained from artificially stripped and fertilized eggs and from the nest of one pair of largemouth bass. The fry were stocked into pools or ponds.

Fathead minnows (*Pimephales promelas*) were stocked into three ponds and four large plastic pools as brood fish to provide offspring as forage for the bass which were added later. Golden shiners (*Notemigonus crysoleucas*) were stocked into the ponds after the bass were added. Fathead minnows, mosquito fish (*Gambusia affinis*) and golden shiners were added at intervals in the small pools after the bass were approximately one-inch long, and in the large pools to supplement the original stocking of fathead minnows.

Samples of approximately 10 bass were taken periodically. The weight and total length of each fish was measured and the fish was returned. When the experiments were terminated, weight and total length were again taken and sex was determined when this could be done without sacrificing the fish.

Seventy-one to 248 bass were stocked as fry or one-inch fingerlings into each pond or pool. Survival to approximately one year of age varied from 1.0 to 34.5%.

Variation in growth rate within individual pools or ponds ranged from 1.9X (largest individual weighed 1.9 times as much as smallest individual in the population) to 20.3X. Coefficient of variability ranged from 14.2 to 94.0. Variation between individuals of a population was, in general, closely correlated with both population density and rate of growth. Variation was greatest in those populations having the greater densities and the slower growing individuals.

Differences in growth rate between the sexes could only be determined in the pond experiments as most bass in the pools did not reach sexual maturity during the study period. In all three pond populations, the males were larger than the females when the experiments were terminated. In Liles', Gay's and Knott's ponds the males averaged 188.0, 163.0 and 363.0 grams, respectively, while the females averaged 162.1, 149.4 and 328.9 grams, respectively. Males attained sexual maturity at a smaller size than females.

PARMLEY, D., G. ALVARODA and M. CORTEZ. 1986. Food habits of small hatchery-reared Florida largemouth bass. Progressive Fish Culturist 48(4) : 264-267.

Linear selection indexes of zooplankton prey taxa (Li) were calculated for 250 hatchery-reared Florida largemouth bass (*Micropterus salmoides floridanus*). Fish began feeding at a mean total length of 6.7 mm and exhibited positive selection for copepod nauplii. Sequentially, selection shifted to copepod adults for 7.5-10.5 mm fish, to adult copepods and cladocerans for 10.9-20.4 mm fish, and, lastly, to predominantly immature insects for 22.8 mm fish. Although selection values were negative for 7.5-10.5 mm fish feeding on cladocerans, 30% more cladocerans than copepod adults were consumed. No rotifers were found in gut contents of fish even though they were present in high numbers in ponds.

PASKO, D. G. 1959. Investigations on the St. Lawrence River between Ogensburg and Massena. Paper presented at the Ontario-New York Conference on Fisheries Research. Watertown, New York.

PEETERS, P. J. 1978. Evaluation of fish stocking in a South Dakota pond. M. Sc. Thesis, South Dakota State University. Brookings, South Dakota.

PELZMAN, R. J. 1980. Impact of Florida largemouth bass (*Micropterus salmoides floridanus)* introductions at selected northern California waters with a discussion of the use of meristics for detecting introgression and for classifying individual fish of intergraded populations. California Fish and Game 66 : 133-162.

Florida largemouth bass (*Micropterus salmoides floridanus*) had a notable genetic impact following their introduction into five northern California waters containing northern largemouth bass (*M. s. salmoides*) populations: Folsom Lake, New Hogan Reservoir, Lake Amador, Lake Isabella, and Clear Lake. Analysis of malate dehydrogenase isozyme patterns of fish systematically collected in years subsequent to the introduction indicated that intergraded populations developed at each of the waters. Incidence of the Florida allele at the study waters, based on malate dehydrogenase analyses, eventually ranged from 0.35 at Lake Amador to 0.52 at both New Hogan Reservoir and Clear Lake.

Discriminate function analysis of meristic data for fish of known electrophoretic phenotype showed that meristic values were not reliable for classifying individual fish from mixed populations as to Florida, northern of hybrid bass categories. This was supported by meristic data from known F_1 hybrids. Hybridization could not necessarily be detected by an increase in mean meristic value of by unimodality of a frequency distribution of meristic values. The mode value of lateral line scale counts appeared to be the best meristic indicator of hybridization.

Information from this study and from a similar study in southern California waters indicates that introduction of Florida bass into northern bass populations have generally been beneficial through reducing high exploitation rates, increasing the mean size of bass in the catch and providing exceptional fishing for trophy-sized bass in some waters. Results of the study indicate that current largemouth bass populations at the study waters possess a wider spectrum of performance capabilities through the inclusion of desirable traits attributed to Florida bass. This is particularly advantageous in the reservoir setting where heavy angling pressure, water level manipulation, competition of prey species with small bass, and other factors work against the maintenance of a bass population.

PESCITELLI, S. M. and R. C. RUNG. 2000. Restoration and protection of smallmouth bass populations in the urban rivers of northeastern Illinois. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

For many years, the urban rivers of Northeastern Illinois experienced severe water quality problems, limiting populations of smallmouth bass and other sensitive sport species. Recently, improvements in water pollution have allowed recovery of the sport fisheries in many rivers. Increased urban angling pressure, and public interest lead to the establishment of management zones on the Fox River to examine the effects of different smallmouth bass regulations. After 3 years, no significant difference in number of larger fish (355 mm) was found among 3 management zones. Other population characteristics will be discussed. A limited creel survey showed lower than expected harvest. Local anglers perceive there has been an improvement in the catch and release zone and are pleased with the regulations. In the DuPage and Des Plaines Rivers, despite presence of good water quality and habitat, recovery has been slow due to dams which block migration from recolonization sources. Stocking of fingerling smallmouth bass has been successful in these rivers. In the first 3 years of study, recapture rates of stocked fish, marked by freeze branding, ranged from 32-50%. Anglers have also caught marked fish and the number of smallmouth bass has increased in the stocked areas.

PHILIPP, D. P. 1991. Genetic implications of introducing Florida largemouth bass (*Micropterus salmoides floridanus*). Canadian Journal of Fisheries and Aquatic Sciences 48 (Supplement 1) : 58-65.

Stocks of northern largemouth bass (NLMB) (*Micropterus salmoides salmoides*), Florida largemouth bass (FLMB) (*M. s. floridanus*), and both reciprocal F_1 hybrids were produced through natural spawning; the genetic composition of each stock was confirmed electrophoretically, and experimental populations established. One set of experimental populations (P1 and P2) contained as broodstock equal numbers of adult NLMB and FLMB, whereas the other set (H1 and H2) initially contained equal numbers of adults of both reciprocal F_1 hybrids and other pure subspecies. Each year-class produced experimentally were sampled and individuals analyzed genetically to determine their parentage. Initially, much of the YOY production in P1 and P2 was composed of small FLMB that did not survive winter well; once naturally produced F_1 hybrids entered the breeding pool, most offspring were F_x hybrids, and the population became heavily introgressed. In H1 and H2 introgression began with the production of the first year-class. Within each year class NLMB produced in all ponds were significantly larger than all other genotypes, but it appears likely that after only a few generations, production of pure NLMB ceases, all individuals being F_x hybrids. Results illustrate the potential negative impacts of introducing FLMB or hybrids between it and NLMB into waters within or contiguous to the native range of the northern subspecies.

PHILIPP, D. P. 2000. Conservation genetics in black bass management. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

Conservation of genetic variation is important not only for the preservation of biological diversity, but also for the maintenance of fitness characteristics of native populations. For the black basses, that involves several issues. First, many historical culture/introduction programs have ignored the fact that genetically distinct stocks of bass exist and have proceeded to transport stocks great distances and mix them with native stocks. This activity results in the loss of native stocks (and in some cases potentially even native species) through interbreeding. Our results also now document the loss in fitness that results from such irresponsible actions. Second, many of our fishing activities impose strong directional selection on our bass populations. Those selective pressures are resulting in a variety of changes in certain phenotypic traits. For example, by angling nesting bass, we are selecting for males that are less aggressive (and less successful?) at defending their broods. By harvesting the largest individuals, we are selecting for fish that are maturing at younger ages and smaller sizes. The bottom line is that if we want to be truly successful in managing black bass, our approaches need to include evolutionary and ecological principles.

PHILIPP, D. P., W. F. CHILDERS and G. S. WHITT. 1981. Management implications for different genetic stocks of largemouth bass (*Micropterus salmoides*) in the United States. Canadian Journal of Fisheries and Aquatic Sciences 38 : 1715-1723.

Genetic differences exist among largemouth bass (*Micropterus salmoides*) populations from different geographic regions of the United States. Stocking of largemouth bass can cause the introgression of genes when stocks from one part of the country are mixed with another. Genetic variation at 28 loci was determined through the use of vertical starch gel electrophoretic analyses. Allelic polymorphism was observed at 16 of these loci. Marked differences in allele frequencies at six of these loci exist among populations. Distinct north-south clinal distributions of the alleles at the MDH-B, SOD-A, IDH-B, and

AAT-B loci suggest a possible involvement of the associated enzymes in the thermal tolerance/preference limits for this species.

We conclude that one or more of these enzymes may be directly involved in temperature tolerance/preference or indirectly associated with temperature-related effects. In either instance, selection (if occurring) may be acting upon the enzyme locus or genes closely linked to it. Through a combination of ecological and genetic principles, it is becoming increasingly feasible to select or construct specific populations of marine or freshwater fish optimally suited for specific environments. Fisheries management programs would benefit from the application of these principles. Multidisciplinary approaches of this nature are essential to maximize the successful conservation and management of our natural resources.

PHILIPP, D. P. and J. E. CLAUSSEN. 1988. Management through stock transfer: Differential performance characteristics of largemouth bass stocks. Presented at the Annual Meeting of the American Fisheries Society 118 : 79. (Abstract only)

Our biochemical genetic evaluation of largemouth bass populations has assessed the level and distribution of genetic variation throughout the natural range of this species. We identified two polymorphic loci (Idh-B and Aat-B) with fixed allelic differences between the two described subspecies, *Micropterus salmoides salmoides* and *M. s. floridanus*, confirming their genetic differentiation. Besides these two diagnostic loci, however, a large number of additional polymorphic loci were also identified suggesting the potential for multiple stocks within each species.

Based upon this high level of genetic variability, different stocks of largemouth bass would be expected to exhibit substantial variation in performance characteristics. Unfortunately, almost no information exists comparing performance traits among genetically defined stocks. Even more unfortunate has been the initiation of stock importation programs that are designed to improve local fisheries but are not based upon sound data or logical inferences.

To compare performance among largemouth bass stocks, we collected brood individuals from a variety of source locations and used parents of known genotypes to produce genetically tagged stocks. Experimental populations were established in a number of widely distributed geographic locations with variable environments. Performance traits (survival, growth, and reproductive success) of each stock relative to the others was determined. To quantitatively determine relative impact of the introduction of each stock on local populations, the degree of interstock hybridization and the relative performance of resulting offspring was also assessed. Results from each of three distinct experiments confirmed that performance of local stocks was greater than that of introduced stocks.

PHILIPP, D. P., J. B. KOPPELMAN, C. KAMINSKI and G. S. WHITT. 1984. Reproductive success of northern, Florida and reciprocal F_1 hybrid largemouth bass in central Illinois. Dingell-Johnson Federal Aid Project IL F-35-R, Job No. 3, Final Report. Illinois Natural History Survey. Urbana, Illinois.

PHILIPP, D. P. and G. S. WHITT. 1989. Northern versus southern stocks of Illinois largemouth bass (Supplemental stocking procedure assessment of largemouth bass: Production of genetically-tagged stocks). Dingell-Johnson Project IL F-35-R, Studies 2, 3, & 5. Illinois Department of Conservation. Springfield, Illinois. 38 p.

Protein electrophoretic methods were used to assess the degree of genetic variability among populations of largemouth bass within Illinois, to assess the genetic differences between northern and southern population extremes, to determine if these extreme populations demonstrated different fitness and performance characteristics. Results are presented from an attempt to produce in the Illinois Department of Conservation hatchery system stocks of largemouth bass with identifiable genetic tags. Results are also presented from a study of the reproductive success of lake trout on Julian's Reef.

PHILIPP, D. P. and G. S. WHITT. 1991. Survival and growth of northern, Florida and reciprocal F_1 hybrid largemouth bass in central Illinois. Transactions of the American Fisheries Society 120 : 58-64.

Stocks of northern largemouth bass (*Micropterus salmoides salmoides*), Florida largemouth bass (*M. s. floridanus*) and both reciprocal F_1 hybrids were produced in Champaign, Illinois, with natural spawning techniques. The genetic composition of each of these stocks was confirmed electrophoretically. Overwinter survival of northern largemouth bass in central Illinois was significantly greater than that of Florida largemouth bass; the two reciprocal F_1 hybrids had intermediate survival. The absolute survival rate of all stocks decreased as the severity of the winter increased; however, the effects were most dramatic for the Florida subspecies. The northern largemouth bass also exhibited greater second and third year growth than the Florida largemouth bass; again, the reciprocal F_1 hybrids were intermediate. Results of this study indicate the potential negative effects that may arise when Florida largemouth bass or hybrids between it and the northern subspecies are introduced into waters of the USA and Canada that are within or contiguous to the native range of the northern subspecies.

PIERCE, P. C. and M. J. VAN DEN AVYLE. 1997. Hybridization between introduced spotted bass and smallmouth bass in reservoirs. Transactions of the American Fisheries Society 126 : 939-947.

Introductions of black basses (*Micropterus* spp.) beyond their native ranges have led to hybridization within the genus. In the southeastern USA, the potential for hybridization appears high because species introductions have been common in reservoirs. We determined the extent of hybridization between smallmouth bass (*Micropterus dolomieu*) and spotted bass (*M. punctulatus*) in reservoirs in which introductions of either species into the native range of the other species had occurred. Three allozyme loci were used to distinguish the two species and their hybrids. Significant hybridization occurred in two of three reservoirs where introductions had been reported. In Lake Chatuge, Georgia-North Carolina, where the Alabama subspecies of spotted bass (*M. p. henshalli*) was introduced 77 of 276 fish had hybrid genotypes and only 2 fish had genotypes of the native smallmouth bass. In Thurlow Reservoir, Alabama, where smallmouth bass were introduced and Alabama spotted bass were native, 3 of 17 fish had hybrid genotypes. Only 1 fish with a possible hybrid genotype was identified in two reservoirs containing native smallmouth bass and northern spotted bass (*M. p. punctulatus*).

PITMAN, V. M. and S. GUTREUTER. 1993. Initial post-stocking survival of hatchery reared fishes. North American Journal of Fisheries Management 13 : 151-159.

We evaluated 24 hour poststocking survival of 10 fish species in the absence of predation. Sixty-six experimental stockings were conducted in 55 freshwater reservoirs. For each stocking, 25 or more randomly selected fry (≤ 16 mm in total length) or fingerlings (> 16 mm in total length) were held in each of three cages submerged at the stocking site. Survival rates of paddlefish (*Polodon spathula*), Florida largemouth bass (*Micropterus salmoides floridanus*), smallmouth bass (*Micropterus dolomieu*), black crappie (*Pomoxis nigromaculatus*), white crappie (*Pomoxis annularis*) and coppernose bluegill (*Lepomis macrochirus purpurescens*) raged from 95.6 to 100%. Survival of striped bass (*Morone saxatilis*) varied from 0 to 100% and differed between size groups; all striped bass fry died. Logistic regression showed associations between survival of striped bass fingerlings and hauling time, pH and conductivity of water in the reservoirs and cumulative changes in temperature and conductivity to which fry were exposed during stocking. Survival of a hybrid of striped bass (*Morone saxatilis* x *M. chrysops*) varied from 0 to 100%; decreased survival of the hybrid fry was associated with decreased dissolved oxygen at stocking sites; and survival of hybrid fingerlings was associated with cumulative changes in pH and conductivity to which they were exposed during stocking. Survival of fry of walleye (*Stizostedion vitreum*) varied from 0 to 34% and was inversely related to hauling time. Survival of fry and fingerlings of red drum (*Sciaenops ocellatus*) varied from 0 to 12% and showed no discernable pattern.

PORAK, W., S. CRAWFORD and D. RENFRO. 1994. Stocking adult largemouth bass and using restrictive harvest regulations in a 24-ha strip-mine lake. American Fisheries Society Annual Meeting 124 : 89. (Abstract only)

Lake 4 (24 hectares) of Tenoroc Fish Management Area was reopened to fishing during July 1991 after a 16-month closure, stocking of 1,300 adult (273 to 635 mm total length) largemouth bass (*Micropterus salmoides*), and a change in bass fishing regulations. New regulations included a 635-minimum size limit, one-fish daily bag limit, and use of artificial lures only. Densities of largemouth bass (> 250 mm TL) increased from 30 bass/hectare in 1990 to 82 bass/hectare in 1991 following supplemental stocking. Anglers caught and released an estimated 1,572 largemouth bass (65 bass/hectare) from July to December, 1991. Sizes of largemouth bass caught by anglers were excellent during this period, with 47% larger than 380 mm TL. Largemouth bass densities declined to 34 bass/hectare in 1992 due to poor survival (4-11%) of stocked largemouth bass. Angler catch rates also declined from 0.60 to 0.08 bass/man-hours during this period. Cumulative stresses, angling-induced stress and low oxygen levels associated with handling of stocked largemouth bass, in Lake 4 were believed to be responsible for high mortality of stocked fish. Improvements were seen in the largemouth bass fishery the following year due to recruitment of a strong 1991 year class.

PORAK, W. F., W. E. JOHNSON, S. CRAWFORD, D. RENFRO, D. KRAUSE, B. DeMAURO and R. STOUT. 2000. Stocking advanced fingerling and subadult largemouth bass raised on artificial feed into Florida lakes. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

We developed feed training techniques to raise largemouth bass (*Micropterus salmoides*) on artificial feeds for stock enhancement studies. New technologies and feeding procedures will be discussed. Ten lakes and two river systems stocked with advanced fingerling (6-13 cm TL) and/or subadult (11-36 cm TL) largemouth bass have been studied since 1994. Stocked largemouth bass were either microwire-tagged or fin-clipped to differentiate them from wild fish. Stocked largemouth bass appeared to be highly vulnerable to angling in Lake Lawne (63 ha) where a creel survey indicated angler catch rates were 1.26 bass/h for 3 months following stocking. Stocked largemouth bass were less piscivorous than wild fish (within the same size range) during the first month after stocking on two stocked lakes where food habit studies were conducted. Mean relative weights (Wrs) of stocked largemouth bass were significantly lower ($P = 0.05$) than wild bass in some cases. Fifty-four stocked and 36 wild largemouth bass were sampled from 7 different stocked lakes to do liver histologies. Twenty percent of the stocked largemouth bass and 0% of the wild largemouth bass had diseased livers. Survival (S) of stocked largemouth bass ranged from < 1% to 34% in 8 study lakes after 1 year, but S was < 3% in 6 of these lakes. Percent contribution of stocked largemouth bass in electrofishing samples ranged from 3% to 14% after 1 year. We will discuss the potential effects of predation, feeding efficiency and disease on the survival of stocked bass.

POWELL, D. H. 1975. Management of largemouth bass in Alabama's state-owned public fishing lakes. p. 386-390 *In* R. H. Stroud and H. Clepper [eds.]. Black Bass Biology and Management. Sport Fishing Institute. Washington, D. C.

Optimum sustained yields of largemouth bass in Alabama's public fishing lakes are obtained through maintaining a balanced fish population. Fish population problems may be either corrected or prevented by utilizing three basic management procedures: corrective restocking of largemouth bass, harvest quotas on largemouth bass, and the introduction of additional species.

There are three techniques of corrective restocking.

The first involves the stocking of 25 to 50 fingerling largemouth bass per acre after treatment of the lake with a fish toxicant. This method is used to correct an overcrowded forage condition that has resulted in no bass reproduction and/or forage fish reproduction.

The second technique involves the stocking of 50 to 100 "early spawned" largemouth bass per acre. This method is used to prevent possible overcrowding of black crappie or golden shiners which spawn before our native largemouth bass.

The third technique involves the stocking of 8- to 10-inch largemouth bass in lakes which show a trend towards crowded forage condition.

The second management procedure utilizes an initial opening harvest quota and an annual harvest quota. After a review and analysis of past opening day catch records and balance checks from the state lakes, biologists determined that 35% of the existing bass population could be removed before closing the lake to bass fishing. An annual harvest quota is also applied based on the past history of balance checks. The annual quota may range from 20 to 50 fish per acre; however, the average harvest is allowed to reach 30 largemouth bass per acre before the lake is closed to bass fishing. A study conducted on 16 of the state lakes showed that a size limit of ten inches and the reduction of the creel limit below six largemouth bass per person per day would not significantly reduce the largemouth bass harvest in the public fishing lakes.

The third procedure utilizes the stocking of additional species. Threadfin shad are stocked as an additional forage species. One study showed an increase in the average size of largemouth bass after the establishment of threadfin shad. Channel catfish and/or white catfish are stocked 100 per acre to serve as additional sport species, thereby reducing the fishing pressure by the average angler on largemouth bass and to serve as additional predators.

These procedures have proved successful in the management of largemouth bass in Alabama's state-owned and managed public fishing lakes. The degree to which they can be applied to other areas of the country should be given considerable study.

PRATHER, E. E. 1970. Fishing success for channel catfish and white catfish in ponds with daily feeding. Proceedings of the Annual Conference of the Southeastern Association of the Fish and Game Commissioners 23 : 480-490.

Fishing success was considerably better for channel than white catfish when stocked at both 2:1 and 1:1 ratios, although white catfish provided good fishing. As the density of catfish increased so did the harvest by fishermen and the use of larger size catfish in initial stocking provided fishing 2 to 3 months earlier than when 5-inch fingerlings were used and resulted in an increase in pounds caught per acre.

At high stocking densities with daily feeding both channel and white catfish spawned when 2 years old, but insufficient young escaped predation where largemouth bass, bluegills and green sunfish were also present. Largemouth bass seldom spawned when stocked with catfish where heavy feeding is used.

PRENTICE, J. A. 1985. Texas statewide Florida largemouth bass fishery management program. Dingell-Johnson Federal Aid Project TX F-31-R-11, Final Report. Texas Parks and Wildlife Department. Austin, Texas. 46 p.

Previously collected data specific to the Texas FLMB were organized, tabulated and reviewed to find reservoirs where the following comparisons could be made: (1) changes in fish communities and/or fishermen harvest before and after FLMB introductions; (2) changes in fishermen harvest and mean weight of the largemouth bass before and after FLMB introductions; (3) degree of success in establishing FLMB genes in LMB populations; and (4) reservoir factors influencing success of FLMB establishment.

PRENTICE, J. and R. BETSILL. 1997. Use of high density largemouth bass populations to improve total fisheries of small city and state park impoundments in Texas. Presented at the 1997 Southern Division of the American Fisheries Society mid-year Meeting. San Antonio, Texas. (Abstract only)

In a series of small (< 10 hectare) city and state park impoundments, creation and maintenance of a high density (> 150 fish per hour in electrofishing samples) largemouth bass (> 150 mm TL) population was attempted to monitor response of sunfish populations and change in angler catch rates. Spring, summer and fall electrofishing and spring and fall angling samples were taken in treated and untreated impoundments. Angler catch rates of both largemouth bass and sunfishes and growth of sunfishes appears to be increasing in treated impoundments. Use of largemouth bass under the legal harvest size in small impoundments may provide a means of improving multiple fisheries with one management action and expense.

RACH, J. J. and T. D. BILLS. 1989. Crayfish control with traps and largemouth bass. Progressive Fish Culturist 51(3) : 157-160.

We attempted to control a population of papershell crayfish (*Orconectes immunis*) in an 11-ha fish-rearing impoundment in Jackson County, Wisconsin, by using traps and stocking largemouth bass (*Micropterus salmoides*). Crayfish were harvested with traps during the summer of 1985, and the pond was stocked with 386 largemouth bass (mean weight, 1.1 kg) in spring 1986. The pond was drained in the fall of 1985 and 1986, and crayfish burrow counts were made to estimate the population. In 1985, we trapped more than 18,000 crayfish, of which 72% were adult males. Trapping had a minor effect on the young-of-the-year crayfish. In 1986, the crayfish population was reduced by 98%, predation by largemouth bass being the probable major cause of reduction.

RAWSON, D. S. 1937$_a$. The introduction of smallmouth bass into Prince Albert Park waters, May 1936. National Parks of Canada. Saskatoon, Saskatchewan. 14 p.

The transfer of smallmouthed bass from Lake Huron, Ontario, to Waskesiu Lake, Saskatchewan, was accomplished in May 1936 with unqualified success, 298 large adults being transported by rail, truck and boat for three days without loss.

The pond culture methods applied to "natural" spawning enclosures in protected bays were also successful, a total of 46 of the enclosed 85 fish spawning. The average number of fry per nest was 4,000 and the total number approximately 85,000. Of these, 19,000 were placed in the Heart Lakes and the remainder in Waskesiu.

Spawning occurred in the last week of June when the water temperature at nest level was between 60 and 67°F. Hatching took place in four days and the fry rose from the nests in 11 days.

Growth was rapid, the average length at the end of August (2 months growth) was more than 2 inches and some individuals were three inches in length. Those (15,000) reared in the feeding enclosure were smaller, but more uniform in size.

It is suggested that further stocking is needed both because we are attempting to establish a new species among a heavy natural population of piscivores and in order to justify the restrictions which must be placed on fishing to protect the bass already planted.

Further planting should include the use of a moderate number of adults in the spawning enclosures. Other important problems to be investigated if possible would be (a) a comparison of the effectiveness of direct planting of fry with the alternative procedure of allowing the male to protect the fry for the usual period of two to four weeks and (b) the possibility of collecting natural food from the lake to feed bass fry.

It is believed that the use of natural rearing enclosures as described above may have very wide application in the propagation of bass and related fishes. A brief technical account of the method is being prepared for presentation at the next meeting of the American Fisheries Society.

RAWSON, D. S. 1937$_b$. Natural rearing enclosures for smallmouth black bass. Transactions of the American Fisheries Society 67 : 96-104.

A new procedure for both the introduction and rearing of smallmouth black bass has been tried in lakes of Prince Albert National Park. The adult bass were transferred before the spawning season and confided in enclosures, screened off, in protected parts of the lake. This procedure allows protection of the parent stock, prevents undesirable scattering, and makes possible accurate observation of survival, spawning activities, etc. Eighty-five adults in enclosures produced 85,000 fry while an intensive search found no nests from 215 bass released in the open lake.

Rearing was accomplished in "natural" enclosures, that is protected areas suitable for spawning and cut off by fences of 1-inch mesh galvanized wire. Within these enclosures the bass were handled according to the usual practice in "artificial" rearing ponds.

The chief advantages of the methods used, lie in the degree of control over the introduction of the adults, the economy of rearing and the ease of distribution of the fry. It is suggested that similar enclosures might be used in breeding and rearing stations either temporary or permanent for bass and related species.

RAWSON, D. S. 1943. The experimental introduction of smallmouth black bass into lakes of the Prince Albert National Park, Saskatchewan. Transactions of the American Fisheries Society 73 : 19-32.

The introduction of smallmouth black bass (*Micropterus dolomieu*) into lakes of Saskatchewan has been attempted unsuccessfully over a period of forty years but never in freshwater lakes of the Churchill River drainage. The need for better game fish in the newly established Prince Albert National Park led to the present experiment which was carried out under close observation. Adult bass were brought from eastern Canada, confined in rearing enclosures, screened off in protected bays and provided with artificial nests. Stocking was begun in 1936 and continued for five summers with some interruption. A total of 1,500 adults were transported and 260,000 fry have been reared. These have been released in Waskesiu and the Heart lakes. Investigations in 1942 showed that the adult bass had survived in fair numbers and were spawning in the Heart lakes. No evidence was obtained that the fry released in the lakes have been reaching maturity. The abundance of piscivorous fish and the immature stage at which these fry were planted are suggested as factors contributing to a high mortality. Experience at Waskesiu Lake suggests that the larger, deeper lakes of this region are marginal as to the temperature toleration of the species. Shallower waters such as the Heart lakes may prove quite suitable for smallmouth bass.

The method of rearing bass in natural enclosures and the successful use of this method has been reported by the author. Further experience with this procedure has demonstrated that egg and fry losses resulting from falling temperatures occur in these enclosures as they do in the usual type of rearing pond. It has also shown the desirability of enclosures where the fry might be fed to avoid planting them in an immature condition.

RAWSON, D. S. and R. A. RUTTON. 1952. Pond fish studies in Saskatchewan. Journal of Wildlife Management 16(3) : 283-288.

Pond fish production in Saskatchewan is still in an early stage of development. Large numbers of reservoirs have been constructed on farm land over the past fifteen years and some of them show the potential for fish stocking. In the summer of 1949, 15 ponds were selected for seasonal observation and 35 new ponds were also studied.

Introductions of largemouth (*Micropterus salmoides*) and smallmouth bass (*M. dolomieu*), bluegills (*Lepomis macrochirus*) and crappies (*Pomoxis* spp.) were introduced into southern Saskatchewan 20 years ago with no success. The reasons for this failure are unknown and so an experiment was carried out to observe the fish under controlled conditions. In the fall of 1950, ponds were filled and stocked respectively with 3-inch white crappies, largemouth bass and adult bluegills. Unfortunately, all of these fish died in late winter, likely because of starvation. In the late summer of 1951, plantings of adult and fingerling largemouth bass were made in three selected reservoirs which are currently under observation.

The program planned for the immediate future involves experiments with warmwater species which can withstand cold winters and provide good quality sportfishing, such as the black bass and the yellow perch.

REDMOND, L. C. 1972. Prevention of overharvest of largemouth bass in Missouri impoundments. p. 54-68 *In* J. L. Funk [ed.]. Symposium on Overharvest and Management of Largemouth Bass in Small Impoundments. American Fisheries Society Special Publication No. 3. Bethesda, Maryland.

Initial harvest of largemouth bass in Missouri's public fishing lakes has been very high. It varied from 11-69% of the adult population during the first 4 days of fishing in lakes of 20 to 205 acres. This has been the primary cause of low adult bass populations, resulting low-quality bass fishing, and high numbers of slow-growing, intermediate-size bluegills. Creel census records revealed that even a very low daily creel limit of bass would not significantly reduce the initial numbers harvested. Various techniques were tried in several lakes to spread to the harvest over a longer period of time to provide better bass fishing and, through heavier predation by the remaining bass population on the bluegills, to produce better bluegill growth and better bluegill fishing. The techniques used were: a "fish for sport only" season prior to lake opening, leaving a lake open to fishing from time of original stocking, mid-winter openings, refuge areas, 40% bass harvest quota, and length limits on bass. A minimum length on bass combined with staggering the initial stocking of forage fishes and stocking several sizes of bass appears to be the best technique found. Creation of a large forage base prior to stocking a reduced number of bass fingerlings, a few adult bass, the normal rate of sunfish, and a later addition of bass fingerlings has resulted in rapid growth of the bass, bass reproduction the following year, and the presence of a broad length frequency range of bass when the lake is opened to fishing approximately 2 years later. A minimum size limit of 14 or 15 in on bass to allow an intermediate harvest of one-quarter to one-third of the original stock has resulted in continuous good bass and bluegill fishing for at least 5 years.

REEVES, C. E., N. NICHOLS and W. C. REEVES. 1995. Hatchery-stocked Florida bass of fingerling recruitment in Alabama reservoirs: Recruitment of hatchery-reared Florida bass fingerlings (FLMB) stocked into Alabama reservoirs with native Northern largemouth bass (NLMB) populations. Dingell-Johnson Project AL F-43-R-11, Study 10, Final Report. Alabama Department of Conservation. Montgomery, Alabama. 10 p.

Binary coded wire tagged FLMB fingerlings were released in William "Bill" Dannelly Reservoir at two locations: Chilatchee Creek park and Bogue Chitto Creek. Objectives were to determine: (1) whether stocking FLMB hatchery-reared fingerlings into weed beds in large reservoirs will increase survival and recruitment of FLMB; and (2) the feasibility of converting stocks of native bass into Florida X native intergrade bass by changing reservoir stocking practices for FLMB fingerlings.

REGIER, H. A. 1960. Bass, bluegills, shiners and farm ponds. New York State Conservationist 14(6) : 18-21, 35.

Pond owners whose water surface area is greater than 0.5-acre can enjoy warmwater and coldwater fishing. The combination of bass and golden shiners is strongly suggested for those who enjoy high quality bass fishing, while the stocking of bass and bluegills is recommended for those who enjoy the taste of bluegill. Studies conducted at Cornell University advocate the stocking of bass and shiners for a more balanced fish population.

REGIER, H. A. 1961. Some aspects of the ecology and management of warm-water fish in New York farm ponds. Dingell-Johnson Project NY F-17-R-6/SP2. Ph. D. Dissertation, Cornell University. Ithica, New York. 436 p.

REGIER, H. A. 1962. On the evolution of bass-bluegill stocking policies and management recommendations. Progressive Fish Culturist 24(3) : 99-111.

In the United States, Federal and some State government agencies supply fish, without charge, for introduction into private ponds, provided that the ponds meet certain specifications. Bluegills and bass are currently the most accepted pond-stocking combination. There currently exists numerous policies and recommendations concerning this grouping which originated in the early 1900s.

Around the Second World War, fishery biologists were discovering that fish need not be stocked quite as often as they were. At this time bluegills and largemouth bass were the most numerous species in the national fish hatcheries. Concurrently, there was a drought in the west and the Soil Conservation Service was encouraging the construction of multi-purpose farm ponds. Since there was an abundance of bluegills and largemouth bass it was natural to place them in these ponds for fishing. Experiments by Swingle and Smith in Alabama led to stocking ratios of bluegills and bass of 1,500 to 100, respectively. The results of this ratio appeared positive and it was then applied to ponds in the southeastern United States as well. Unfortunately, the results from Alabama did not repeat themselves outside the southeast. The general discontent with the bass-bluegill results, except in selective areas of the southeast, apparently convinced the Fish and Wildlife Service that a single policy for all parts of the country was undesirable. However, this combination has remained popular because there appears to be a lack of an alternative. Other pairings are currently being tested for efficiency, such as the substitution of redear sunfish instead of bluegills in the area of surrounding Texas, Nebraska and Ohio. Channel catfish are used in Oklahoma and Kansas, while other stocking attempts are being made with smallmouth bass or largemouth bass alone or largemouth bass in conjunction with golden shiners. Further research needs to be done before any such "all-encompassing" policy is put into practice.

REGIER, H. A. 1963$_a$. A cost analysis of farm ponds in Tompkins County, New York. Progressive Fish Culturist 25(3) : 144-148.

Landowners typically decide to build or manage a pond on their property if they believe that the benefits will outweigh the costs. This paper addresses the costs associated with farm pond construction and management in Tompkins County, New York. Fixed costs include such things as the value of the land, the cost of planning, the cost of construction and additional expenditures for landscaping and fencing. The costs concerning the maintenance of a pond and of the fish species in that pond are more variable. While coldwater ponds are characteristically stocked with rainbow or brook trout, warmer ponds are usually occupied with a combination of largemouth bass.

The largemouth bass-golden shiner combination requires approximately 100 fingerling bass and 400 adult shiners to every acre. At a price of $15 and $4 for 100 bass and shiners, respectively, it is estimated that long term (20 year) bass-shiner management costs would be $75 in a 0.3 acre pond. This value includes restocking every eight years and the cost of fertilization. In contrast, the largemouth bass-bluegill combination necessitates 100 fingerling bass and 1,000 fingerling bluegills be planted every eight years, at a cost of $15 and $3 to the hundred, respectively. Over 20 years, in a fertilized pond this combination would cost $175. Although these figures are given based upon the economic and topographic features of Tompkins County, it is expected that these numbers will be applicable elsewhere in the northeastern United States.

REGIER, H. A. 1963$_b$. Ecology and management of largemouth bass and bluegills in farm ponds in New York. New York Fish and Game Journal 10(1) : 1-89.

To construct a factual and reasoned basis for a fish-stocking and management policy applicable to farm ponds in New York, various species and species combinations were studied. This paper concerns largemouth bass (*Micropterus salmoides*) and bluegills (*Lepomis macrochirus*) stocked according to three different formulae. Data on survival, growth, reproduction, standing crops, harvests, and population condition were summarized and compared. Pond-owner preferences and practices, and pond costs, were determined.

It was concluded that a bass-bluegill combination might prove satisfactory in: (1) larger, deeper New York ponds whose surface temperatures rise above 80°F for several weeks each summer; (2) ponds whose weeds can be controlled; (3) ponds whose owners have a genuine interest in fishing and managing the pond for bluegills as well as bass. A majority of farm ponds in New York likely do not meet this criteria.

REGIER, H. A. 1963$_c$. Ecology and management of largemouth bass and golden shiners in farm ponds in New York. New York Fish and Game Journal 10(2) : 139-169.

Experiments with largemouth bass and golden shiners were conducted in farm ponds in central New York, and the results were compared with those from experiments with largemouth bass and bluegills. Natural mortality of originally stocked bass was somewhat lower in bass-shiner ponds than in bass-bluegill ponds. Growth rates of bass were somewhat higher in bass-shiner ponds. Bass reproduction was more regular in the bass-shiner ponds. Therefore, standing crops of bass tended to be considerably higher in bass-shiner ponds, permitting larger harvests. In spite of satisfactory initial reproduction and suitable spawning sites, shiner populations began to decline 2 years after stocking and disappeared in some ponds, presumably due to predation. Standing crops of bass increased and bass reproduction continued, in spite of decreasing shiner populations.

Stocking with the bass-shiner combination should be encouraged on a trial basis in New York ponds. This combination may be more advantageous than bass and bluegills for the pond owner who is not particularly interested in bluegills and whose pond is quite small and fairly shallow with a surface temperature that rises above 73°F in the summer.

REYNOLDS, R. D. 1973. Introduction of smallmouth bass (*Micropterus dolomieui*) to Angus Lake in Temagami District. File Report. Ontario Ministry of Natural Resources. Temagami, Ontario. 2 p.

Angus Lake is located ten miles south of Lake Temagami in Ontario. Surveys conducted in 1959 and 1972 indicate the presence of only pickerel and northern pike as sportfish, yet both surveys recommended the introduction of smallmouth bass (*Micropterus dolomieui*).

Coarse gravel was added to the lake to provide spawning grounds and twenty-five smallmouth bass were transplanted from Granite Lake (ten miles north of Temagami) to Angus Lake. As of yet there have been no results but posters have been distributed to alert fishermen of the presence of the smallmouth bass and in the spring close watch will be kept on the gravel beds. It is also recommended that seine netting should be carried out.

RICKER, W. E. 1949. Effect of removal of fins upon the growth and survival of spiny-rayed fishes. Journal of Wildlife Management 13(1) : 29-40.

Among young largemouth bass 48 mm long, living with a "normal" population of other fish, including large predators, the removal of one pectoral fin, or both ventral fins, or a pectoral and both ventral fins in July resulted in significantly decreased survival from that time to November, during which time they grew 50 mm on the average. The magnitude of the effect is estimated as an increase of 0.24 in the instantaneous mortality rate, or 50% of the mortality rate of unmarked fish. From November to the following May the marked individuals suffered an additional 50% excess mortality, which increased the instantaneous rate of 0.83 for unmarked fish to the 1.24 for marked ones. The total differential of 0.65 corresponds to a survival rate, among marked bass, 52% as great as that of unmarked bass. During their second summer of life, larger piscivorous fish were absent from the pond and there was no excess mortality among the marked bass as they grew from 95 mm to 178 mm.

During the winter period mentioned above, mortality was heaviest among the larger bass of both the marked and unmarked groups. A similar greater vulnerability of large individuals might explain the fact that, at the end of the previous summer, the survivors of the marked individuals were significantly smaller (4.7 mm) than were the unmarked ones. However, it is also possible that marking affected the rate of growth directly.

RICKETT, J. D. 1976. Growth and reproduction of largemouth bass and black bullheads cultured together. Progressive Fish Culturist 38(2) : 82-85.

The culturing of two or more species of fish together has brought widespread interest. Largemouth bass (*Micropterus salmoides*) is most often used in combination with another species. The success of rearing largemouth bass and black bullheads (*Ictalurus punctatus*) together and largemouth bass and channel catfish (*I. Melas*) together, was tested in stocked ponds.

In 1970, eight ponds of 0.04 ha in area where stocked with ten yearling largemouth bass. In addition, 150 yearling black bullheads were stocked in two of these, 100 channel catfish (*I. Melas*) in two, and 150 bullheads plus 100 channel catfish in two. All ponds containing two species received supplemental food equal to 3% of the total weight of the catfish. The results of this experiment indicated that yearling bass grew fastest when stocked with channel catfish only and slowest when stocked alone. It is suspected that the supplemental feed stimulated the growth and production of benthic prey. In a 1972 study it was discovered that young bass when stocked with bullheads initially experience faster growth rates than bullheads. When stocked alone, the bass have a more rapid rate of growth and were found to have attained a greater total length when the ponds were drained.

In 1971, reproductive studies demonstrated that the number of young produced by the spawning bass was inversely related to the number of bass spawning. There was evidence for cannibalism and it is assumed that the density of the fish was detrimental to egg and fry survival.

Ultimately, bullheads are a better forage species to plant alongside bass, because of their ability to spawn in the ponds, as opposed to the channel catfish.

RIDEAU LAKES FISHERY ASSESSMENT UNIT. Undated. Stocking history of Big Rideau Lake. File Report. Ontario Ministry of Natural Resources. Kemptville, Ontario. 3 p.

The stocking of all species into Big Rideau Lake is presented. Smallmouth bass were initially planted into the lake in 1911.

RIEGER, P. W. 1975. Evaluation of the introduction of Florida bass into an Oklahoma reservoir receiving a heated effluent. Oklahoma Cooperative Fisheries Research Unit. M. Sc. Thesis, Oklahoma State University. Norman, Oklahoma. 67 p.

RIEGER, P. W. and R. C. SUMMERFELT. 1976. An evaluation of the introduction of Florida largemouth bass into an Oklahoma reservoir receiving a heated effluent. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 30 : 48-57.

The purpose of this study was to observe growth, survival and spatial distribution of the Florida largemouth bass (*Micropterus salmoides floridanus*) and of the northern subspecies (*M. s. salmoides*) in an Oklahoma reservoir thermally enriched by a heated effluent from an electrical generating plant. Hatchery-reared fingerlings of both subspecies were stocked in 1974 and 1975 after they were marked with either fluorescent pigments sprayed into the dermis, or with magnetized metal injected into the nasal cartilage. Growth of the Florida subspecies was greater than that of the northern subspecies in both years of the study, but the difference was significant in 1975. Overwinter survival of Florida bass was lower than that of northern bass in both years and was especially low (1.6%) during the winter of 1974-75 when lake temperatures were lower than during the winter of 1975-76. Spatial distribution of Florida bass during the winter of 1974-75 was largely limited to the vicinity of the thermal plume.

RIEGER, P. W., R. C. SUMMERFELT and G. E. GEBHART. 1978. Catchability of northern and Florida largemouth bass in ponds. Progressive Fish Culturist 40 : 94-97.

Four 0.1-ha ponds were used to evaluate differences in vulnerability to angling between 1- and 2-year-old northern largemouth bass (*Micropterus salmoides salmoides*) and Florida largemouth bass (*M. s. floridanus*). In a total of 32 man-hours of fishing in two 3-day periods in June and July 1976, anglers captured 91.5% of the northern bass but only 58.3% of the Florida bass. Only a trivial difference was observed in the vulnerability of age I and age II bass of either subspecies. Of the 37 northern bass marked and released during a June fishing interval 22% were recaptured during a July fishing interval: none of the 10 marked Florida bass were recaptured. Fishing was with plugs, spinners, and live golden shiners (*Notemigonus crysoleucas*). Of the Florida bass 52% were caught with plugs, 43% with shiners and 5% with spinners; of the northern bass, 20% were caught with plugs, 53% with minnows and 27% with spinners.

RIEL, A. D. 1967. Merrymeeting Lake perch control. Dingell-Johnson Project NH F-11-R-6, Job No. 1. New Hampshire Fish and Game Department. Concord, New Hampshire. 8 p.

RIVERO, L. H. 1936. The introduced largemouth bass, a predator upon native Cuban fishes. Transactions of the American Fisheries Society 66 : 367-368.

The introduction of largemouth bass in certain Cuban waters, where fed fish food is limited and native fish species few in number, has resulted in the partial or complete eradication of the native cyprinodonts, and subsequent increase in malaria, the malaria-carrying mosquito and other mosquitoes; it has not, as was hoped, provided a new and abundant source of food; and it has finally necessitated the destruction of the bass in order that cyprinodonts may again inhabit the waters where they formerly occurred and again hold the mosquitoes in check.

ROBBINS, W. H. and H. R. MacCRIMMON. 1974. The black bass in American and overseas. Biomanagement and Research Enterprises. Sault Ste. Marie, Ontario.

The authors present a concise look at smallmouth bass populations throughout America and in Europe. The range of smallmouth bass in the United States and Canada is quite broad and became so during the last glacial period. Geographically isolated areas contain native populations of the fish. The last glacial incursion allowed the bass to enter previously unavailable lakes and streams and establish some of the populations enjoyed today. Extensive stocking in the northeastern and central states in the latter 1800s contributed to the existing bass populations. Smallmouth bass have been stocked in nearly all contiguous states, except Florida and Louisiana, but not all stocking have been successful. Canadian smallmouth bass fisheries have the same history as bass in America. Glaciation allowed populations to be established in Ontario and Québec, and stocking programs introduced populations to the other provinces. Alberta and Saskatchewan no longer have self-sustaining populations. Four documented introductions of bass into Central and South America have resulted in one actual population, in Belize, and a supposed population in Costa Rica. South Africa supports an extensive smallmouth bass population in Cape Province from which stockings for other provinces/countries have ensued. Natal and Orange Free Province now support naturalized populations. In Europe, Belgium and Sweden are the only countries of 15 stocked which support self-sustaining populations and those are limited due to heavy angling pressure in Belgium and cold summer water temperatures in Sweden.

ROBINSON, D. W. 1961. Stream and lake survey: Stream reclamation, District One. Dingell-Johnson Project W. VA F-10-R-2, Job No. 4. West Virginia Division of Game and Fish. Charleston, West Virginia. 11 p.

ROGERS, W. A. 1968. Food habits of young largemouth bass (*Micropterus salmoides*) in hatchery ponds. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 21 : 543-553.

The most important food items of largemouth bass stocked into hatchery ponds were copepods, cladocerans, and midges.

Using primarily midge larvae as an index to food organism length, it was found that the larvae increased in length as fish increased in length up to a size of 30 mm, after which the larger food organisms apparently were no longer available resulting in the larger fish having to revert back to smaller forms.

The greatest volume of food was copepods and cladocerans in the 5 and 10 mm fish groups with midge larvae and pupae becoming most important in fish examined larger than the 15 mm group.

Adult midges comprised 50 and 40% of the food volume in the 45 and 50 mm fish groups, respectively.

Ostracods were found regularly in all fish size groups larger than 15 mm, but only started to become a significant item in the larger fish. Various insects were taken occasionally, but were insignificant as food items.

The average number of major food items consumed was erratic with the highest number of copepods (21.8) being reached in the 20 mm fish group. Cladocerans averaged 11 per fish in the 5 mm fish group. Midges reached the highest average number of 9.6 in the 35 mm group.

Both copepods and cladocerans occurred in 100% of the 5 mm fish group and generally declined in percent frequency of occurrence until the cladocerans disappeared in the 40 mm fish group and the copepods from the 45 mm group.

Midge larvae occurred in approximately two-thirds of the fish of 15 mm or smaller and consistently occurred in 80-95% of the larger size groups.

The method of using area of the food organisms as an index to relative volume proved to be very satisfactory.

ROSEBERY, D. A. 1950. Fishery management of Claytor Lake, an impoundment on the New River in Virginia. Transactions of the American Fisheries Society 80 : 194-209.

Claytor Lake in Southwest Virginia, covering 4,495 acres of a mountainous section of Pulaski County, was formed by the construction of a dam in 1939. The lake is 21 miles long, has a maximum width of one half mile, and a maximum normal pool elevation of 1,846 feet above sea level. During the period 1939-1946 the lake was stocked with 650,000 walleye fry, 74,854 young bluegills, 3,570 adult bluegills, 12,040 adult yellowbelly sunfish, 20,135 young largemouth bass, 10,813 adult largemouth bass, 3,000 young smallmouth bass, and 3,894 young white crappie. In spite of the heavy stocking, largemouth bass and yellowbelly sunfish failed to become important species in the lake.

Until 1946 the impoundment was closed to walleye and bass fishing each year from December 31 to June 20. After 1946 all fishing was prohibited during the December 31 to June 20 period. The fishes of Claytor Lake exhibit slow growth for the first year but after the second year the growth rate is considered good. The bluegill is the principal forage fish, but its population is restricted by competition with the channel catfish and crappie for food. Angling success on Claytor Lake is usually low.

In 1948 the best fishing occurred during June and October when returns of 0.11 and 0.14 pounds of fish were caught per hour and the poorest fishing was in August with a return of 0.072 pounds of fish per hour. The harvest of bluegill, white crappie, walleye, and channel catfish by anglers was low during the 1948 and 1949 fishing seasons. Tagging returns suggest that anglers realized the highest rate of harvest, a 20 to 30% return, from spotted and smallmouth bass.

As a result of the findings of the Claytor Lake Fisheries investigation, it was recommended that:

1) The fishing season be extended to the entire 12 months for all species of fish with the exception of the black basses, for which the season should be closed during the months of April and May;
2) The introduction of the gizzard shad be investigated for producing a plankton-shad-bass and walleye food chain;
3) Attempts be made to popularize the fishing for bluegill, crappie, and channel catfish to increase the harvest of these species;
4) Creel census be continued to determine any changes in the composition of the fish population, in sport fishing conditions, and in the approximate harvest of sport-fish populations;
5) Fish collections be made to determine current food habits, population changes, age-growth rate, and similar life history data.

RUTLEDGE, W. P. and B. A. GREGG. 1989. Catchability of smallmouth bass hatchery broodstock promotes catch-and-release program. p. 118-120 *In* D. C. Jackson [ed.]. The First International Smallmouth Bass Symposium, August 24-26, 1989, Nashville, Tennessee.

The Texas Parks and Wildlife Department conducted a "Veteran Broodfish Program" using surplus hatchery brood fish to promote catch-and-release fishing. Smallmouth bass (*Micropterus dolomieui*) brood fish were tagged and released throughout Texas. The public was encouraged to release these fish when caught and to report their capture to an angler recognition program using a toll-free number. Angler recapture rates during the first 18 months ranged from 7 to 54%. Multiple recaptures occurred in several reservoirs and one fish was recaptured and released five times. Initial program results confirmed that large smallmouth bass are quite vulnerable to angling, including multiple recaptures, but because of this program, many anglers released the fish.

RYAN, M. J., M. A. WEBB and L. T. FRIES. 1996. Contribution of largemouth bass reared in nursery ponds to year classes in two Texas reservoirs. Proceedings of the Annual Conference of Southeastern Association of Fish and Wildlife Agencies 50 : 131-138.

Genetically-marked Florida largemouth bass (*Micropterus salmoides floridanus*) fingerlings with rare or unique genotypes were stocked into nursery ponds at Lake Conroe (8,484 ha) and Lake Gladewater (323 ha). Following grow-out, advanced-sized individuals were stocked into respective reservoirs. We measured the contribution of stocked individuals to corresponding year classes in receiving reservoirs. Largemouth bass survival in nursery ponds at the end of the grow-out period was 15.6% at Lake Conroe and 20.9% at Lake Gladewater. A total of 2.8 fish/ha (mean total length = 138 mm) were stocked in Lake Conroe and 8.8 fish/ha (mean total length = 121 mm) were stocked in Lake Gladewater. Following reservoir stockings, largemouth bass populations were sampled with electrofishing gear in fall and spring and electrophoretic analysis was conducted to evaluate the contribution of stocked fish to corresponding year classes. Largemouth bass from nursery ponds comprised 0.0%, 5.0% and 0.0% of the 1991 cohort at Lake Conroe in October 1991, April 1992 and November 1992 electrofishing samples, respectively. Largemouth bass from Lake Gladewater nursery ponds comprised 4.5%, 6.7% and 0.0% of the 1992 cohort in December 1992, March 1993, and March 1994 electrofishing samples, respectively. Returns from nursery pond stockings were low with minimal contribution to year classes in study reservoirs.

SADOWSKY, J. 1988. Smallmouth bass assessment, Cooper Lake. File Report. Ontario Ministry of Natural Resources. Kapuskasing, Ontario. 3 p.

On July 5, 1988, a gill netting exercise was conducted on Cooper Lake in an attempt to determine the survival of 102 adult largemouth bass that were introduced into the lake in 1984. Also, small fish collections were carried out to determine any recruitment of bass as a direct result from spawning of the adult fish. The assessment consisted of gill nets set at two locations resulting in a total of 5 hours and 25 minutes of netting pressure. Only one northern pike and one cisco were captured. Small fish collections consisted of 11 seining attempts with a 15 m seine. No juvenile bass were captured. A 30 cm dip net with 0.2 cm mesh was used to capture 11 juvenile smallmouth bass. Juvenile smallmouth bass were also observed near the mouth of the outlet. This confirms natural recruitment from the introduced bass.

SAILA, S. B. 1952. Some results of farm pond management studies in New York. Journal of Wildlife Management 16(3) : 279-282.

The number of farm ponds in New York has increased rapidly over the past few years. It is estimated that 3,254 ponds have been constructed. The information obtained for this report was based upon pond observations of greater than fifty ponds since 1949.

Bass-bluegill is the most common warmwater combination used in farm ponds. Their suggested planting ratio is 1,000 bluegill to 100 bass. When this criteria is adhered to in New York it appears to give inconsistent results. It is suspected the water temperatures which are quite different in New York than they are in Alabama (where this ratio has enjoyed success) are to blame.

Successful bluegill reproduction may occur only one year following the initial plant if conditions are favorable, but at most there is only one hatch per year. The planted largemouth bass have never spawned successfully until 2 years of age. For this reason all fishing during the second and third season following stocking is limited to the original stock. A wide assortment of stocking ratios from 2:5 to 1:10 bass to bluegills have been tested with little variation in angling success. Because of this lack of consistency and unsatisfactory results from the bass-bluegill combination the use of new species groupings will hopefully prove to offer greater farm pond population yields.

SASAKI, S. 1961. Introduction of Florida largemouth bass into San Diego County. Inland Fisheries Administrative Report 61-11. California Department of Fish and Game. Sacramento, California. 6 p.

SASAKI, S. 1971. Introduction of Florida largemouth bass into San Diego County, California. Inland Fisheries Administrative Report 71-11. California Department of Fish and Game. Sacramento, California.

SATTERFIELD, J. R. and S. A. FLICKINGER. 1986. Use of yearling largemouth bass for initial stocking of small impoundments. p. 375-380 *In* R. H. Stroud [ed.]. Fish Culture in Fisheries Management. American Fisheries Society. Bethesda, Maryland.

In an attempt to decrease lag time between initial stocking and the development of a fishable largemouth bass population, yearling rather than young-of-the-year largemouth bass were stocked into six reclaimed small impoundments in Colorado. Stocking density was 70 largemouth bass per surface acre. Largemouth bass spawned in five of six study impoundments one year after stocking (the other impoundment suffered a winter-kill) and most individuals reached quality size in that amount of time. After two years in three of the study impoundments, largemouth bass proportional stock density (PSD) and relative stock density of preferred length fish (RSD-P) values ranged from 37% to 50% and 13% to 25%, respectively. After one year in two impoundments, PSD and RSD-P values ranged from 8% to 48% and 0 to 17% respectively. Based on PSD, RSD-P and relative weight (Wr) values, largemouth bass populations appear to be developing desirable fishing opportunities. Stocking combinations including yearling rather than age-0 largemouth bass are currently recommended as a possible stocking option to small impoundment owners in Colorado. In instances where it is important to produce fishable populations as soon as possible, the small extra expense of yearling largemouth bass may be justified.

SEALE, A. 1910. The successful transference of black bass to the Philippine Islands, with notes on the transporting of live fish long distances. Philippine Journal of Science 10 : 153-159.

SHARP, J. 1897. The large-mouthed black bass in Utah. Bulletin of the United States Fish Commission 17 : 363-368.

SHEBLEY, W. H. 1917. History of the introduction of food and game fishes into the waters of California. California Fish and Game 3(1) : 1-12.

The California Fish Commission during the first decade of its existence introduced into the waters of this state a number of varieties of food and game fishes and the attending results are regarded as being among the greatest achievements in fish-culture and acclimatization.

Both species of black basses have been introduced into California. The first smallmouth bass (75 individuals) were introduced by Dr. Stone in 1874 to Napa Creek from Lake Champlain, Vermont. At the same time 12 bass were planted into Alameda Creek from St. Joseph River, Michigan. Further introductions were made in 1879 by Dr. Stone into Crystal Springs Reservoir. All these plantings were successful and the fish quickly increased in numbers. Stockings were also made in Lake Cuyamaca and the Feather River. Finally, in 1895, 2,500 largemouth bass were sent to the Sisson hatchery for fish culture purposes and were subsequently used to stock other waters.

Annually the Fish Commission distributes bass from crowded waters and deposits them into public fishing areas. Both the smallmouth and largemouth bass are currently highly sought after for food and sport and are of great importance to the California fishery.

SHELLEY, J. J. and T. MODDE. 1982. First year growth and survival of bluegill and black bullhead stocked with largemouth bass in South Dakota ponds. Progressive Fish Culturist 44(3) : 158-160.

Largemouth bass and bluegills planted together appear to be the most successful fish combination in the Midwestern United States. This blend, however, has not proven to be as productive in northern states such as New York, Michigan and Montana. As an alternative, South Dakota was divided into quadrants and combinations of black bullhead, largemouth bass, and bluegills were stocked into four randomly selected ponds in each quadrant. Bass were stocked at 247/ha, black bullhead at 988/ha and bluegills at 1,236/ha. The effect of stocking a species alongside largemouth bass was evaluated.

First year bluegill survival ranged from 6 to 69% (a mean value of 32%) in three South Dakota ponds. In contrast, the survival rate of the black bullhead in three ponds ranged from 62-71% (a mean value of 68%). It is suspected that the survival rate was high because of the high stocking rate. In the future, it is proposed that the bass-black bullhead combination would benefit from a reduction in the bullhead stocking density to a level of 247/ha.

SHIELS, A. L. and L. L. JACKSON. 1993. Development of a largemouth bass population under a 381-mm minimum length limit in a reclaimed Pennsylvania impoundment. p. 26 *In* Managing Black Bass In Northern Waters. Northeast Division of American Fisheries Society Warmwater Workshop, October 5-6, 1993, Alexandria Bay, New York. (Abstract only)

A 381-mm minimum length limit on largemouth bass (*Micropterus salmoides*) was evaluated during 1988-1990 and 1992 at a reclaimed 23.9-hectare Pennsylvania impoundment immediately opened to fishing in April 1986. Objectives of the length limit, effective January 1, 1987, were to prevent initial overharvest of largemouth bass, improve age-size structure, and increase the size of bass harvested. Bass were sampled via May night electrofishing. Largemouth bass densities ranged from 58/ha in 1989 to 38/ha in 1990. Biomass estimates ranged from 11.49 kg/ha in 1990 to 18.35 kg/ha in 1989. Total annual survival was 30.7% in 1989, 42.0% in 1990, and 34.5% in 1992. Proportional stock density (PSD) values were 59 in 1988, 47 in 1989, 30 in 1990, and 31 in 1992. Relative stock density (RSD-375 mm) values were 6 in 1988, 13 in 1989, 16 in 1990, and 8 in 1992. RSD-450 mm values were 0 in 1988, 0 in 1989, 3 in 1990 and 1992. The 381-mm minimum length limit prevented overharvest of largemouth bass while the lake remained open to fishing. Rapid growth of 1986 and 1987 stocked fingerlings facilitated precocious reproduction at age-2 resulting in uninterrupted recruitment. Size structure was improved with increased abundance of harvestable bass.

SHRADER, T. 1993. Status of introduced largemouth bass in Crane Prairie Reservoir. Information Report No. 93-3. Oregon Department of Fish and Wildlife. Salem, Oregon. 38 p.

Data on largemouth bass were collected from 1987-1992, using an electrofishing boat to sample in the spring and/or fall. Objectives were to: (1) determine the effect of the increasing bass population on the quality of the trout fishery; (2) determine how to optimize fisheries on trout and bass; and (3) characterize the bass population.

SKELTON, P. 1993. On bass in Blindekloof – the impact of an alien predator on a wilderness stream. Naturalist (South African) : 37(2) : 21-27.

SMILEY, C. W. 1882. Removal of the bass from Indiana to North Carolina by the United States Fisheries Commission. Bulletin of the United States Fisheries Commission 2 : 116.

SMITH, B. W. and D. C. KELLER. 2000. Largemouth bass in small impoundments: Management outside the black box. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

Management standards for largemouth bass (*Micropterus salmoides*) in small impoundments were established in the 1950s by Bennett and Swingle. Many private and agency controlled small impoundments continue to be managed using paradigms developed by these pioneers. Concerns of early managers included lack of largemouth bass reproduction and recruitment, and overharvest. Current management problems are now commonly opposite, and small impoundment owners and anglers have more demanding goals and expectations than those of previous decades. Changes in owner profiles, increased awareness of management, and sophistication of angling techniques have contributed to the need to develop and implement innovative management strategies. We have successfully altered traditional stocking practices to achieve significantly faster growth and increased prey availability. Other new management techniques we use include; aqua-scaping new impoundments, aeration and destratification, feed training and use of automatic feeders, diversification of prey species, stocking of all-female largemouth bass, and employment of electrofishing for population evaluation and selective removal. Additionally, we are reevaluating broad-scale stocking of Florida largemouth bass, previously thought to be the panacea of trophy bass management. We contend that innovative management techniques are necessary to achieve the quality of largemouth bass fishing demanded by this century's landowners and anglers.

SMITH, B. W. and W. C. REEVES. 1986. Stocking warm-water species to restore or enhance fisheries. p. 17-29 *In* R. H. Stroud [ed.]. Fish Culture in Fisheries Management. American Fisheries Society, Fish Culture Section and Fisheries Management Section. Bethesda, Maryland.

Fish stocking is still understood very little by the average person. Because of past difficulties warmwater stocking is much less common today than in the past. This paper attempts to relate the importance of warmwater fish culture to fisheries management throughout the United States.

There are four types of stocking which occur:

1) Maintenance stocking – is executed to maintain a certain fish density in a body of water
2) Enhancement/Supplemental stocking – increases the abundance of an existing species
3) Introduction stocking – the planting of fish in an area where the species has never occurred
4) New water stocking – this is the stocking of new or reclaimed waters

Early stockings of the largemouth bass occurred in water bodies where they were absent or present in very small numbers. All life stages, fry, fingerlings, advanced fingerlings and adults are stocked. Fry, fingerlings and adults are typically used in introduction stocking. Enhancement stocking usually involves fingerlings (of all sizes) and adults. Reclaimed or rehabilitated waters typically receive fry. Reported stocking rates vary greatly by location. Fry are stocked from 50 to 100 per acre, while fingerlings range from 25 to 200 per acre in new/reclaimed stocking and 5 to 100 per acre for enhancement stocking. The current popularity of the fast-growing Florida largemouth bass has increased the number of introductions, which are done in hopes of influencing the northern largemouth bass gene pool.

Twenty-two states are currently stocking the smallmouth bass. The stocking of fingerlings and adults is common, while adults are typically transfers from other lakes. Most smallmouth bass were found to be stocked as introductions in streams and lakes, yet there were instances where fish were planted for maintenance stocking. The stocking rates varied to such an extent within those states which could provide rates that it is obvious there exists no consensus on which rate is most effective. The smallmouth bass is of much less importance than the largemouth.

SMITH, B. W., C. E. WHITE, Jr. and G. R. HOOPER. 1975. Management techniques for largemouth bass in Alabama ponds. p. 380-385 *In* R. H. Stroud and H. Clepper [eds.]. Black Bass Biology and Management. Sport Fishing Institute. Washington, D. C.

This chapter presents a summary of intensive bass management practices which have been successful in Alabama ponds. Much of the information is founded on the basic pond management principles set forth at Auburn University by H. S. Swingle. Pond management of largemouth bass (*Micropterus salmoides*) is influenced by many factors. Construction; stocking; growth rates and reproduction; and various management practices are discussed in relation to the management of largemouth bass.

Pond stocking greatly influences the management of the largemouth bass. Various rates, ratios, and combinations of largemouth bass and forage species will yield predictable, yet diverse populations. The largemouth bass, bluegill and redear sunfish have been the most successful combination planted in Alabama farm ponds. The rate of stocking recommended by the Game and Fish Division (in a fertilized pond) includes 100 fingerling bass (planted in late spring) plus 750 bluegills and 250 redear sunfish (planted the previous fall) on a per acre basis. Ideally this ratio would result in a balanced system, with bass between three-quarters to one pound and sexually mature following a year in the pond and bluegill weighing four ounces which would spawn the first summer. Stocking adult bass at a rate of two pair per surface acre and five to ten pairs of adult bluegills may also help achieve a balance population. Stocked bass can also be accompanied by fathead minnows, golden shiners or threadfin shad.

If unbalanced populations, in the favor of intermediate forage fish, results from stocking there are a few measures which can be taken in an attempt to "balance" the pond. Bluegills can be killed using rotenone or fintrol, bass fishing on the pond can be halted, or additional bass 3- to 5-inches can be stocked at the rate of 25 to 50 per acre.

Currently, the bass-bluegill-redear combination is the most successful and is highly recommended as it provides a large variety of sizes of bass. Average size largemouth bass in a balanced pond will provide excellent fishing for anglers who enjoy short periods of time between strikes.

SMITH, E. V. and H. S. SWINGLE. 1942. Percentages of survival of bluegills (*Lepomis macrochirus*) and largemouth black bass (*Huro salmoides*) when planted in new ponds. Transactions of the American Fisheries Society 72 : 63-67.

In contrast to the low percentage of survival to be expected when bluegills and largemouth black bass are planted in streams and old lakes, high percentages are obtained when these fish are planted in new ponds. Survivals of 75 to 100% were obtained when bluegill fingerlings alone were planted in ponds in which food was plentiful. In bluegill-bass combinations, survivals of 76 to 85% were obtained for bluegill fingerlings. Percentages of survival for largemouth black bass in bluegill-bass combinations were 75 for fingerlings and 80 to 90 for advanced fry. Recognition of the high survivals of these species forms one of the bases for an intelligent stocking program for new ponds.

SMITH, E. V. and H. S. SWINGLE. 1943. Results of further experiments of the stocking of fish ponds. Transactions of the North American Wildlife Conference 8 : 168-179.

Bluegills grow rapidly in newly stocked, properly managed ponds before spawning, but grow slowly or lose weight during the prolonged spawning season.

Bluegills should be stocked late in the summer or early in the fall (preferably September) to permit maximum growth to occur before spawning.

Stocking with a few bluegills one fall and waiting until the following fall to add bass will result in an unbalanced pond and is not recommended.

The "bottle-neck" in producing bass for stocking new ponds can be greatly reduced by substituting advanced fry for fingerlings.

The percentage of survival is much more important where bass fry are planted than where fingerlings are used because the bass, planted as fry, cannot spawn until one year after stocking. The survivals have been high where bass fry have been carefully stocked and low where they have been carelessly handled or, in some cases, where they have been transported for considerable distances.

Where bass, planted as fry, fail to spawn the spring following stocking, it is recommended that a second planting of fry be made.

Where ponds are built on streams containing various minnows, it is recommended that the bass be stocked as fingerlings, or, if fry must be used, that more than 100 be planted per acre or that they be added in 2 successive years.

SMITH, G. 1971. Florida largemouth bass in Southern California. Florida Wildlife 25(4) : 30.

SMITH, H. M. 1896. A review of the history and results of the attempts to acclimatize fish and other water animals in the Pacific states. Bulletin of the United States Fish Commission 15 : 379-472.

SMITH, N. W. 1991. Fish stocking in the southwestern region, 1974-1989: A historical review. Ontario Ministry of Natural Resources, Southwestern Region. London, Ontario. ii + 79 p.

Fish stocking as a fisheries management technique in the Southwestern Region, Ministry of Natural Resources is reviewed for the period from 1974 to 1989. This review includes Ministry initiatives as well as those undertaken by groups participating in the Community Fisheries Involvement Program (CFIP).

In Aylmer District no largemouth bass have been stocked by the Ministry since 1978. In 1977, 35,000 fry were stocked for rehabilitation purposes and 40,000 the next year with the same intention. CFIP participants stocked, in 1989, 50 adult largemouth bass for the purpose of a put-and-take fishery.

In the Owen Sound District, the Ministry stocked 10,000 largemouth bass fry in both 1975 and 1976 for supplementation purposes. In the following two years, 1977-1978, 15,000 bass fry were stocked, half as a method of rehabilitation and the remainder for introduction into new water bodies. There has been no stocking since this time.

In Simcoe District, the Ministry of Natural Resources has not planted largemouth bass since 1974 when 5,000 were introduced as fry for the purpose of supplementation. Unfortunately, the results of this planting effort have not been documented.

There were no plantings of largemouth bass in Chatham or Wingham districts. Much of warmwater stocking effort is being put into walleye introduction and rehabilitation.

SMITH, R. P. 1976. A growth comparison of two subspecies of largemouth bass in Tennessee farm ponds. M. Sc. Thesis, University of Tennessee. Knoxville, Tennessee. 27 p.

SMITH, R. P. and J. L. WILSON. 1981. Growth comparison of two subspecies of largemouth bass in Tennessee ponds. Proceedings of the Conference of the Southeastern Association of Fish and Wildlife Agencies 34 : 25-30.

A study was conducted to determine if any growth rate differences occurred between two subspecies of largemouth bass during the first 6 months of growth. Two ponds near Lenoir, Tennessee, were partitioned into equal halves by a nylon fish barrier. Northern strain fingerlings (*Micropterus salmoides salmoides*) were stocked in one side of each pond and Florida bass (*M. s. floridanus*) in the other sides. *Micropterus salmoides salmoides* showed a significantly faster rate of growth (1.0% level) than *M. s. floridanus*. Mean coefficients of condition (K) and specific growth rates (G) were consistently higher for *M. s. salmoides* during the study period. Since the subspecies were grown in the same water under apparently similar environmental conditions but separated by a barrier, growth differences observed from the fingerling state (1 month old) to 5 months of age were thought to be genetic in nature.

SMITH, W. A., J. B. KIRKWOOD and J. F. HALL. 1955. A survey of the success of various stocking rates and ratios of bass and bluegill in Kentucky farm ponds. Fisheries Bulletin 16. Kentucky Department of Fish and Wildlife Resources. Frankfort, Kentucky. 42 p.

SMITHERMAN, R. O. 1975. Experimental species associations of basses in Alabama ponds. p. 76-84 *In* R. H. Stroud and H. Clepper [eds.]. Black Bass Biology and Management. Sport Fishing Institute. Washington, D. C.

Fingerling and yearling basses of seven species – redeye bass, spotted bass, largemouth bass, shoal bass, smallmouth bass, Suwannee bass, and Guadalupe bass – were tested in various species associations in ponds at Auburn University, Auburn, Alabama. All grew well, but only redeye bass and largemouth bass matured and successfully reproduced at 12 months of age.

Largemouth bass was the most effective in controlling bluegill and fathead minnow populations. Spotted bass showed promise in controlling these species, but failed to reproduce in the second summer. Redeye bass spawned, but had little effect on bluegill or fathead minnow. Smallmouth was a good sport fish alone, but was not an effective predator when stocked in combination with bluegill.

When stocked together with other pond species, largemouth and spotted basses had similar food habits, consuming twice as much forage fish as did redeye bass. In all experiments with equal opportunity for growth, largemouth bass grew the largest, followed by spotted bass and redeye bass.

Relative growth rates of basses in a fertilized pond with no forage minnows ranked as follows: spotted bass, shoal bass, smallmouth bass, and redeye bass. Growth rate in ponds with bluegill and fathead minnow ranked: largemouth bass, spotted bass, and redeye bass. Growth and final size in ponds with unlimited fathead minnow ranked the basses as follows: largemouth bass, spotted bass, shoal bass, Suwannee bass, smallmouth bass, and redeye bass.

SNOW, J. R. 1968. Production of six to eight inch largemouth bass for special purposes. Progressive Fish Culturist 30 : 144-152.

This study of the feasibility of rearing larger sizes of largemouth bass on a combination of natural and artificial food indicates that the technique has considerable promise as a means of providing fish of specified sizes for special purposes. Two possible uses are: (1) supplying limited number of 6- to 8-inch fingerlings for corrective restocking in ponds crowded with a forage species, and (2) providing test animals for bioassay work. A substantial reduction in the production costs is considered possible; this would make extensive use of larger largemouth bass more practical.

Bass reared to a size of 8 inches on a fish-dry food mixture and stocked at rates of 10 to 100 per acre in small hatchery ponds adjusted to a diet of live forage fish. The survival and growth were considered excellent in all instances. Successful reproduction at the age of 1 year was a further indication that growth of fed fish was comparable to that of fish receiving natural food.

SNOW, J. R. 1973. Controlled culture of largemouth bass fry. Proceedings of the Annual Conference of the Southeastern Association of Game and Fish Commissioners 26 : 392-398.

A method for the controlled production of largemouth bass (*Micropterus salmoides*) fry is described. This method was based upon use of artificially-fed brood fish which were stocked into small earthen ponds equipped with nylon felt spawning mats. Eggs deposited on the mats were separated, cleaned, and incubated in a Health Vertical Incubator. Fry hatched in one to two days and were held until swim-up in holding troughs or shipped during the yolk sac absorption stage.

A trial of the technique in 1972 resulted in approximately 2,714,00 eggs being collected from 563 fish stocked in seven 0.1-acre ponds. From these eggs, 1,564,000 fry were hatched and survived (57.6%) to swimup or for shipment as sac fry.

Twenty-two percent of the eggs collected were infertile according to examination of samples removed during processing. Subtracting this percentage from the total number of eggs collected gives an estimated 2,117,000 which could have hatched. Usable fry production was 1,546,000 or 73.9% of the viable eggs incubated.

Five age class of adults were included in the stocking. Best egg production was from five-year-old females, with an average of 2.0 spawns each, followed by two-year olds with 1.9 spawns each. Three-, four- and one-year age classes produced 1.3, 0.9 and 0.8 spawns respectively per female stocked.

The advantages and disadvantages of the method are discussed along with some possible applications.

SNOW, J. R. 1975$_a$. Hatchery propagation of the black basses. p. 344-356 *In* R. H. Stroud and H. Clepper [eds.]. Black Bass Biology and Management. Sport Fishing Institute. Washington, D. C.

Hatchery propagation of the centrarchid basses has been concerned mainly with the largemouth and to a lesser extent with the smallmouth bass. The limited experiments reported for the 5 other species suggests that the methods used in largemouth and smallmouth culture are adaptable to these as well.

The most practical method of mass producing bass fingerlings up to a total length of 4 inches (10 cm) is to stock small bass of an appropriate size into prepared rearing ponds at a density governed by the size being reared.

Fry can be produced in a spawning pond under the care of the parent fish or obtained by use of a specialized technique controlled by the fish culturist.

Beyond a size of 4 inches, artificial feeding in either a pond or raceway environment seems more feasible for a production of large numbers of fish. Although efficiency of food supplies declines beyond a size of 8 inches (20.3 cm), it is technically possible to rear largemouth bass to adult size if the need exists.

Growth and maintenance of hatchery brood stock is commonly done with a forage fish ratio, and probably is the best approach for most hatcheries. However, there are advantages to using artificial feed which could make this procedure worthwhile in many situations.

Additional research appears to be needed in the intensive culture of largemouth bass to increase success in feeding the smallest size fry artificially. Study of methods for rearing adult bass in large numbers on artificial food also is needed. If a need for mass culturing the species of basses other than largemouth and smallmouth develops, it will be necessary to verify the assumption that the present systems are effective in culturing them.

With these exceptions, it appears that existing hatchery technology has the capability to meet any reasonable demand for black bass of any size, provided that facilities, funds, and manpower are made available.

SNOW, J. R. 1975$_b$. Fish production in a central Alabama stock water pond. Proceedings of the Annual Conference of Southeastern Association of Game and Fish Commissioners 28 : 217-221.

The use of suitably constructed and located stock water ponds for food fish culture is recommended, based upon investigation into the possibilities of these small bodies of water to rear a channel catfish-largemouth bass combination. Stocked with 2,000 catfish and 100 bass per acre with supplemental feeding, two, two-year production cycles showed the following results: total fish production, 2,634 and 3,791 pounds per acre; feed conversion, 2.5 and 2.4%; recovery of stocked catfish, 84 and 91%; recovery of stocked bass, 40 and 50%. In addition to supplying food fish, the pond provided recreation through the fish cultural activity and through hook-and-line fishing.

SNOW, J. R., D. BREWER and A. C. F. WRIGHT. 1978. Plastic bags for shipping sac fry of largemouth bass. Progressive Fish Culturist 40(1) : 13-14.

Shipping fish in plastic bags has been an accepted fish cultural practice for many years. A preliminary trial was made in 1970 to determine the length of time bass fry could survive in sealed plastic bags. Encouraging results from this work led to an investigation into loading rates and post-shipment survival in 1971 and to feasibility studies of shipping bass fry to hatcheries in 1972, 1973, and 1974.

After making preliminary tests of fry densities in shipping bags ranging from 250 to 12,000/liter, we accepted a density of about 3,000/liter as being most likely to result in both satisfactory survival to destination and economical use of shipping container space. Although survival of largemouth bass fry to destination was excellent (3-year average, 87.5%), survival to distributable size was not. Most of the receiving hatcheries obtained some return, however, and one reported an average survival to the distributable size of 78.4% (75% first year, 81.8% the second).

We conclude that the technique of shipping largemouth bass fry by the method described is worthy of general application where an adequate supply of larvae can be provided. The ultimate success of this approach appears dependent on rearing conditions at the receiving hatcheries.

SNUCINS, E. J. and B. J. SHUTER. 1991. Survival of introduced smallmouth bass in low-pH lakes. Transactions of the American Fisheries Society 120(2) : 209-216.

We measured survival of caged, overwintering young-of-the-year and introduced, free-swimming adult smallmouth bass (*Micropterus dolomieu*) in five Ontario lakes that varied in pH from 4.9 to 5.9 (winter values). No hatchery-reared young survived in lakes that ranged in pH from 4.9 to 5.9 and in total aluminum from 55 to 215 µg/L. The only lake in which young survived the winter (2-100% survival) had a pH of 5.9 and a total of Al of 34 µg/L. Survival of overwintering young in the laboratory was high (92-100%) at all pH levels tested (4.9-6.0). Differences in metal (Al, Cu, Zn, Ni, Mn) concentrations may account for survival differences between the field and laboratory and between lakes with a similar pH. Adult smallmouth bass were transferred to four of the same lakes (19-24 fish/lake) used for the experiment on young fish. Population size estimates for the introduced adults were obtained from snorkeling surveys conducted during three spawning seasons (1987-1989). Estimated population size, expressed as a percentage of the number stocked, was highest (41-55%) in the lake with pH 5.9, lowest (4-12%) in the lake with pH 5.4, and zero in two lakes with pH 4.9-5.2.

SNYDER, N. and S. GIRARD. 1991. Species composition netting in Raft Lake, McGowan Township. File Report. Ontario Ministry of Natural Resources. Kapuskasing, Ontario. 3 p.

Raft Lake was stocked in 1985 with 50 smallmouth bass. Other fish species in Raft Lake are northern pike, yellow perch, walleye and white sucker. On August 9, 1991, an assessment was done to evaluate the survival and reproduction of the smallmouth bass introduction. Two 400-foot gill nets were set in the lake for durations of one hour to approximately one and one-half hours. No fish were caught. It is suggested that another assessment be conducted next year and that overnight sets be used to better determine the status of the smallmouth bass population in Raft Lake.

SOMERS, K. M. 1986. Population characteristics of the crayfish (*Cambarus bartoni*) in lakes with and lakes without introduced populations of smallmouth bass

(*Micropterus dolomieui*) in Algonquin Provincial Park, Ontario. Faculty of Graduate Studies, University of Western Ontario. London, Ontario. xi + 302 p.

Populations of the crayfish *Cambarus bartoni* from six lakes in Algonquin Provincial Park, Ontario were compared to evaluate the influence of an introduced predator, the smallmouth bass (*Micropterus dolomieui*). Bass were introduced into a variety of lakes in the southern portion of the park in the late 1800s and early 1900s to diversify the sport-fish community. Crayfish populations from three lakes containing bass were contrasted with populations from three lakes without bass.

Comparisons of relative abundances, patterns of habitat use and length-frequency distributions were compromised by seasonal changes in crayfish trappability and differences in crayfish species composition. Catches of *C. bartoni* in baited traps were lower in lakes containing bass and in lakes with greater numbers of co-occurring crayfish species. The presence of bass did not affect trap catches of *C. bartoni* from different habitats, but traps failed to catch small crayfish that were vulnerable to bass predation. Length-frequency distributions of trap catches varied among lakes with no consistent pattern associated with the presence of bass. In contrast, trap catches contained proportionately more large crayfish in lakes with more crayfish species.

Frequency of cheliped loss among populations of *C. bartoni* was highest in lakes with greater numbers of crayfish species. Only females displayed increased incidences of claw loss in lakes with bass. Female *C. bartoni* in two lakes containing bass were characterized by a smaller size at maturity. Females from the third lake with bass exhibited a size at maturity similar to populations from lakes without bass, yet smaller females produced proportionately more eggs than similarly sized females in any of the other lakes. Ovarian egg counts indicated that size-specific fecundity was higher among populations from lakes containing bass. However, the magnitude of the increase in fecundity ranged from 4 to 35% above values from populations in lakes without bass.

C. bartoni from lakes containing bass differed morphologically from crayfish in lakes without bass. Populations experiencing bass predation displayed a common form characterized by a more robust carapace, larger chelipeds and a smaller rostrum. Females from lakes with bass had wider tails, whereas males had narrower tails than crayfish from lakes without bass. The magnitude of sexual dimorphism was reduced in lakes with more crayfish species. However, the presence of bass reduced the influence of the number of crayfish species and enhanced sexual divergence in morphology.

STEVENSON, F. 1973. Evaluation of the Florida strain of largemouth bass in Ohio. Federal Aid in Fish Restoration F-29-R-13, Final Report. Ohio Inland Fisheries Research Unit. Columbus, Ohio.

STOCEK, R. F. and H. F. MacCRIMMON. 1965. The co-existence of rainbow trout (*Salmo gairdneri*) and largemouth bass (*Micropterus salmoides*) in a small Ontario lake. Canadian Fish Culturist 35 : 37-58.

A sport fishery was maintained between 1958 and 1962 in a 41.7 acre lake by annual plantings of yearling hatchery-reared rainbow trout and the natural reproduction of introduced largemouth bass. Because of unfavourable summer limnological conditions in the hypolimnion and lower thermocline, both species were obliged to co-exist in the upper 10-15 feet of surface water. An average annual fishing pressure in 1961-62 of 155 angler-hours per surface acre harvested 5.1 trout and 5.5 bass, or 4.6 pounds of these species per surface acre. Angling success was 0.05 bass and 0.06 trout per angler-hour. Factors affecting the survival, distribution, and fishing quality of both species are discussed.

STONE, C. C. 1981. Growth and survival of largemouth bass in newly stocked South Dakota impoundments. M. Sc. Thesis, South Dakota State University. Brookings, South Dakota. 73 p.

STONE, C. C. and T. MODDE. 1982. Growth and survival of largemouth bass in newly stocked South Dakota ponds. North American Journal of Fisheries Management 2(4) : 326-333.

This study evaluated the growth and survival of age-0 and age-I largemouth bass (*Micropterus salmoides*) in South Dakota ponds relative to five stocking combinations and various environmental parameters. Species stocked with largemouth bass included golden shiners (*Notemigonus crysoleucas*), fathead minnow (*Pimephales promelas*), black bullhead (*Ictalurus melas*) and bluegill (*Lepomis macrochirus*). Stocking of largemouth bass only also was evaluated.

Differences in first-year growth among four geographic regions of the state were significant ($P < 0.05$). Analysis of variance indicated no significant difference ($P > 0.05$) in first-year largemouth bass growth due to the combinations stocked. Young-of-the-year growth rates in 34 ponds ranged from 101 to 196 mm, with a mean of 153 mm. Relative weight (W_r) values for largemouth bass ranged from 100 to 135, with a mean of 114. No significant differences in Relative Weight ($P > 0.05$) were observed among regions or combinations.

First-year survival values for 16 eastern South Dakota ponds ranged from 0 to 100%, with a mean of 50%. The highest largemouth bass survival occurred in ponds stocked with largemouth bass only; survival of largemouth bass stocked with bullheads was the lowest.

Stepwise multiple regression of selected chemical, physical, and biological parameters indicated that the number of growing days, turbidity, presence or absence of fathead minnows, and salinity were significant ($P < 0.05$) factors influencing first-year largemouth bass growth in South Dakota.

STRAW, M., A. LINDER and J. LINDER. 1997. The boom in smallmouth bass. The Journal of Freshwater Fishing 22(7) : 36-44.

At no time in recent history has the smallmouth bass fishery been so productive. In a variety of waterbodies such as lakes (including the Great Lakes), rivers and reservoirs smallmouth bass populations are experiencing a huge increase in numbers. This sudden jump has been attributed to a multitude of circumstances. The clearing of waters by zebra mussels and stringent environmental regulations is allowing the smallmouth bass to better detect their prey, which in turn leads to larger, healthier fish. Also, smallmouths have been observed exploiting unused habitat and even displacing other species. Presently, it appears that the stocking of smallmouth bass which took place ten to fifteen years earlier is finally beginning to show in light of the change in environmental conditions.

For example, Lake Oahe was stocked with smallmouths from 1983 to 1989 and halted following observed natural reproduction. By the early 1990s the smallmouths had begun to occupy areas where no stocking had occurred. Lake Texoma has experienced similar success. In 1981, smallmouths were first planted, and this continued until 1983. Presently natural reproduction is high and the fish are colonizing different areas of the lake.

It appears that a combination of factors and circumstance is needed to push a stocked population to achieve its potential as a valuable sportfish resource.

STRICKLAND, D. 1985. Smallmouth bass. *In* Fishing in Algonquin Park. Ontario Ministry of Natural Resources and Friends of Algonquin Park. Whitney, Ontario. 31 p.

With few exceptions, the current populations of smallmouth bass in Algonquin Park are the result of introductions. The first planting was made as early as 1899. Approximately half of the lakes containing smallmouth bass are along the Highway 60 corridor for easy accessibility, the total numbering around 79. Lake Opeongo is the most important of these stocked lakes, providing one fish for every three hours of fishing time. However, not all of the smallmouth bass introductions had positive effects. They are blamed for the destruction of many brook trout populations.

STROUD, R. H. 1955. Harvests and management of warm-water fish populations in Massachusetts' lakes, ponds, and reservoirs. Progressive Fish Culturist 17(2) : 51-63.

For a study of angler-harvest of Massachusetts warm-water fishes, 12,978 catchable-size largemouth bass, smallmouth bass, chain pickerel, brown bullheads, white perch, and yellow perch were tagged, in 107 ponds comprising about 18,750 surface acres, during the 3-year period between September 1950 and October 1953. Of these fish, 4,829 were native to the ponds where they were caught, tagged, and released; 8,149 were salvaged from water supplies closed to fishing and released in public waters.

Recovery of tags was largely by voluntary mailings by anglers. Partial creel census and a reward system prevailed at two ponds. A comparison of returns under these conditions with returns from certain other waters not subject to these influences indicated that about 75% of the recovered tags were actually reported. This was applied as an expansion factor to all known returns to estimate harvest.

Known recoveries among native fishes amounted to 20% or more of small lots of smallmouths, 60% of pickerel, 10% of bullheads, 5% of white perch and 8% of yellow perch.

Selective mortality among salvaged fish was extensive, being estimated to involve at least one-third of all largemouths, smallmouths, white perch, and yellow perch, and about one-half of all pickerel stocked in the fall. About one-third of the pickerel stocked in spring may also have died shortly after release. Most bullheads probably survived after release. Salvaged fish may have been more vulnerable to angling than "natives."

In a few ponds estimated harvests of salvaged fish were exceptionally high, namely, 28% largemouths, 61% smallmouths, 64% pickerel, 16% bullheads and 36% yellow perch.

Though undoubtedly less costly than producing equivalent harvests of catchables in established populations by means of continuous hatchery plantings, it cost the license buyers an estimated $11 plus for each pound of salvaged fish reaching the creel – a prohibitive figure.

Salvage and transfer for purposes other than biologically sound introductions or restocking after reclamation (or equivalent) cannot be justified on a cost basis. Amounts of money corresponding to the "salvage budget" would provide many times as much fishing if invested in reclaiming unbalanced waters and providing permanent access to public waters.

SUMNER, R. E. 1968. Species combinations in small impoundments. Dingell-Johnson Project W. VA F-10-R-10, Job No. 2, Final Report. West Virginia Division of Game and Fish. Charleston, West Virginia. 15 p.

SURBER, E. W. 1945. The effects of various fertilizers on plant growth and their probable influence on the production of smallmouth black bass in hard-water ponds. Transactions of the American Fisheries Society 73(1943) : 377-393.

The bass ponds supplied with hard water at the United States Fishery Experimental Station, Leetown, West Virginia, are naturally unproductive of fish, due to impenetrable growths of Chara which invade them soon after they are filled and persist throughout the period of their operation.

The addition of cottonseed or soybean meals alone to these ponds failed to increase production over that of unfertilized ponds. When timothy hay and cottonseed meal were combined with superphosphate, increased fish production resulted. The results with hay 10 parts:superphosphate (20%) 1 part were outstanding. Three ponds fertilized with this combination averaged 190 pounds of bass per acre. High production of fish is apparently correlated with plant decay.

Water blooms have not been produced consistently by any combination of inorganic fertilizers yet tried. Evidence is presented to demonstrate that their production is associated with certain nutrient elements released by plant decay.

A 12-5-5 inorganic fertilizer combination contains the proper proportions of nitrogen, phosphorus and potash to stimulate the early spring growth of *Spirogyra* and the summer growth of *Cladophora glomerata*, *Oedogonium*, *Hydrodictyon*, and *Zygnema*. *Cladophora* was the characteristic summer filamentous algal form when this fertilizer was used. These algae smother out *Chara* and indirectly increase fish production.

Ponds fertilized with a 13-5-5 inorganic combination gave better fry survival and production of smallmouth black bass when filled in November 1942 and wintered wet than did ponds filled in early April 1943.

SURBER, E. W. 1949. Results of varying the ratio of largemouth black bass and bluegills in the stocking of experimental farm ponds. Transactions of the American Fisheries Society 77(1947) : 141-151.

During the period 1943 to 1946, several combinations of largemouth black bass (*Micropterus salmoides*) and bluegill (*Lepomis macrochirus*) were stocked in ponds on the station grounds at Leetown, West Virginia. These ponds were fertilized with 12-5-5, inorganic fertilizer, but when water blooms failed to control the submerged vegetation, sodium arsenite or copper sulfate was occasionally used for this purpose.

Bluegill-bass ratios varying from 8:1 to 15:1 were used. Inventories of ponds showed that approximately 199 pounds of edible fish per acre could be produced annually in well-managed ponds at Leetown regardless of the stocking ratio employed. The average size of bluegills varied inversely with the number stocked. The smallest bluegills, produced in the 15:1 bluegill-bass ratio, averaged about 5.7 inches in fork length, compared with about 6.5 inches from the 8:1 ratio. Largemouth bass failed to make good growth in the 15:1 ratio, averaging only 9.3 inches compared with 10.2 inches in the 8:1 inches ratio.

The fact that in two ponds 71% of the largemouth black bass in the original stocking were removed during a brief period suggests that good pond management may include removal of fish in the same ratio as the original stocking, to assure maintenance of a balance of species.

SURBER, T. 1924. Introduction of smallmouth bass in north shore streams, Minnesota. Fish, Feathers, Fur 4 : 257.

SWINGLE, H. S. 1945. Improvement of fishing in old ponds. Transactions of the North American Wildlife Conference 10 : 299-308.

Because of the rapid increase in pond construction during the past few years, in many sections there was no program available for the management based on adequate research. Consequently many ponds have been improperly managed and are failures from the standpoint of fish production. Experiments dealing with the renovation of old ponds have been conducted in Alabama during the past 10 years. The types of investigations necessary to determine the corrective measures to be employed and the relative values of various corrective measures are discussed in this paper.

Experiments have demonstrated that, for the best fishing over the longest period of time, ponds in the Southeast must be stocked with both bluegill bream and largemouth black bass, but that additional species may be used if desired. If either bass or bluegills are not present in a pond, corrective restocking with that species should first be resorted to.

For good fishing to result, the fish-feeding species (such as bass) and the insect-feeding species (such as bluegills and other forage fish) must be present in proper balance. In ponds with unbalanced populations, relatively few bream and very few bass can be caught. Methods for the determination of balanced or unbalanced conditions and the corrective measures necessary are discussed. Correction of an unbalanced condition in one pond resulted in a 90% increase in the catch.

Fertilization to increase the food supply has been found to increase the fish-carrying capacity of Alabama ponds 300 to 400%. Because fertilization aids in weed control and increases the ease with which fish can be caught, the average catch over a 5-year period in a fertilized pond exceeded that in an unfertilized one by 879%.

Weed control is one of the principal problems involved in the renovation of old ponds. Control of *Najas guadalupensis* in a pond, without materially changing its fish-carrying capacity, resulted in a 23% increase in the catch of fish. Pond fertilization should be used whenever possible in weed control because the resulting growth of plankton greatly retards or prevents the growth of weeds except in very shallow water.

Yearly restocking for the improvement of fishing was of no value.

SWINGLE, H. S. 1949$_a$. Some recent developments in pond management. Transactions of the North American Wildlife Conference 14 : 295-312.

During the last 15 years in the United States, approximately 100 times as many ponds were constructed as were built in the preceding 2 centuries. The great interest in and the continuing construction of ponds over the entire country indicate that, on the whole, the program is a success. This was made possible only through the cooperative assistance rendered pond owners by State and Federal agencies. The problem, however, of educating approximately a million new pond owners in methods of water farming for fish production is a tremendous one and a certain amount of failures must be expected.

Research is continuing in a search for better pond species and more efficient combinations of fish. The bluegill-largemouth bass combination is still the best one for most of the United States. However, recent investigations have indicated limits to its usefulness. Since bluegills do not produce young until the surface water of the pond reaches 80°F, this combination cannot be used in colder waters. The bluegill normally feeds on the pond bottom in water less than 15 feet in depth; consequently, it does not efficiently utilize the food in extremely deep impoundments.

The red-ear bream or shellcracker is one of the better species for use in combination with bluegills and largemouth bass in ponds in the Southeast. This fish grows at a much more rapid rate than the bluegills, but apparently lacks winter-hardiness.

Pond waters heavily laden with silt because of erosion, wading by stock, or heavy wave action are unsuitable for planting bluegills and bass. Reduction of the silt content of these waters is necessary before they are useable for fish production.

The bass-bluegill combination is not satisfactory in unfertilized ponds with areas of less than 0.5 acre or in fertilized ponds with areas less than 0.25 acre because they support an insufficient number of bass to ensure adequate reproduction.

SWINGLE, H. S. 1949$_b$. Experiments with combinations of largemouth black bass, bluegills and minnows in ponds. Transactions of the American Fisheries Society 76(1946) : 46-62.

Various combinations of largemouth bass, bluegills, golden shiners, gizzard shad, and *Gambusia* were stocked in 0.25-acre experimental ponds. The ponds were fertilized with inorganic fertilizer. After 1 or 2 years the ponds were drained and the fish counted and weighed. The bluegill proved the most desirable fish, although it did not result in the highest bass production in these experiments. It appeared to offer promise of the highest sustained yield of bass over a period of years. Golden shiners gave higher bass production for a 1- to 2-year period, but could not maintain high production over a longer period. Goldfish could not be used with bluegills because the latter ate goldfish eggs and prevented reproduction. Goldfish also were not satisfactory when used with bass only, because many young grew too large for bass to eat and ate their own eggs, thus preventing further reproduction. Gizzard shad produced a high poundage of bass but the young rapidly grew too large for bass to eat and overcrowded the ponds. As a result, they stopped reproducing and at the same time reduced bluegill production. *Gambusia* were unsatisfactory as forage fish because bass eliminated them almost entirely from the ponds in a few months.

SWINGLE, H. S. 1951. Experiments with various rates of stocking bluegills (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*) in ponds. Transactions of the American Fisheries Society 80(1950) : 218-230.

Results from stocking adult bluegills and largemouth bass, fingerling bass and adult bluegills, and fingerling bluegills and fingerling largemouth bass are compared. Increase in rates of stocking bluegills from 8 to 1,500 per acre in bluegill-bass combinations gave corresponding increases in pounds of harvestable fish per acre and corresponding decreases in the cost per pound. The calculated A_t value (percentage harvestable fish) could be used to predict the success of various stocking rates. Unbalanced populations resulted from stocking with insufficient numbers of either largemouth bass or bluegills. When normally adequate numbers of each species were stocked, unbalanced populations occasionally resulted from extremely high mortality among the stocked fish. Where no fish were removed by fishing, an average of 25.6% of the stocked bass died during the first six months and an additional 20.4% during the following year; similarly an average of 15.4% of the stocked bluegills died during the first year and an additional 19.1% during the second year.

SWINGLE, H. S. 1952. Farm pond investigations in Alabama. Journal of Wildlife Management 16(3) : 243-249.

The largemouth and smallmouth basses are only a couple of the species being tested for pond culture suitability at Auburn University. Results of these investigations will be applied to the enrichment of pond life in private Alabama ponds, of which there were approximately 700 as of 1934.

The bass-bluegill combination is among the most widely used in rearing ponds and was found to be dependent upon the weight of fish a pond could support. The accepted rate for fertilized ponds is 100 largemouth bass and 1,000 bluegills per acre. These numbers were varied slightly for experimental reasons and 1,500 bluegills plus 100 bass were found to give the highest catch per acre, although 1,000 bluegills plus 100 bass gave a higher poundage of bass.

Many bass-stocked ponds have been destroyed by premature fishing. It is important that no bass are removed from the pond for at least one year after stocking, so that they may have time to spawn. Balanced ponds with the bass-bluegill combination have been known to provide excellent fishing for up to seven years.

Largemouth bass were planted with a variety of other species in experimental ponds to determine which combination would deliver the highest annual catch. Results demonstrated that 100 bass per acre alone gave 42.2 pounds per acre on an annual basis; 1,500 green sunfish and 100 bass, 74.9; 1,500 shellcrackers and 150 bass, 188.6; 750 shellcrackers plus 750 bluegills and 150 bass, 214.5; 1,500 bluegills and 150 bass, 239.4; and 1,500 bluegills plus 25 white crappie and 150 bass, 282.2.

SWINGLE, H. S. 1956. Determination of balance in farm fish ponds. Transactions of the North American Wildlife Conference 21 : 298-322.

Methods of determining balance in pond populations include: (1) seining technique called pond analysis, (2) use of catch records, (3) population values and ratios calculated upon the entire population and upon samples, and (4) the marking and recovery technique.

Pond analysis is a process of deduction of the state of balance from the degree of reproduction of (previously planted) bass and bluegills, and the relative abundance of intermediate bluegills. It is based on factors affecting reproduction: size of brood fish, food availability during egg formation, crowding by the same species or other species, egg-eating habit, repressive factor, water temperature, silt, water fluctuation, salinity, pH, and light. A key is given relating the kinds, sizes and numbers of fish caught in a minnow seine and in a 50-foot seine with 0.5-inch mesh to the state of balance of the population.

Balance was estimated from the sizes and kinds of fish caught by fishermen. In unbalanced ponds, the catch was principally intermediate bluegills with occasional large bass, and bluegills were never caught on beds. In balanced ponds, the catch was principally composed of bluegills larger than the 6-inch group, and bass from 1 to 2 pounds, with bluegills found on beds several times yearly. In ponds crowded with bass, the catch was composed of bluegills averaging over 0.3 pounds and bass less than 1 pound.

Population values were found useful in expressing balance, with the most valuable being A_T, the percent by weight of harvestable sized fish in a population, and F/C, the number of pounds of forage fish per pound of piscivorous fish in the population.

Samples from use of rotenone or a 50-foot seine with a 0.5-inch mesh gave low estimates of the pounds of fish per acre, but when converted into population values gave relatively accurate measures of balance.

Marking and recovery estimations of populations were inaccurate. This and other estimation techniques greatly need intensive investigation and development.

SWINGLE, H. S. 1966. Biological means of increasing productivity in ponds. Proceedings of the FAO World Symposium on Warm-Water Pond Fish Culture, May 18-25. Food and Agricultural Organization of the United Nations. Rome, Italy. Fisheries Report 44, Volume 4(V/R-1) : 243-257.

SWINGLE, H. S. 1970. History of warmwater pond culture in the United States. p. 95-105 *In* N. G. Benson [ed.]. A Century of Fisheries in North America. American Fisheries Society. Bethesda, Maryland.

A major problem that must be faced when stocking bass and bluegills into ponds is the balance of the individual stocking rates. In the United States it has been found that the maximum number which should be stocked is from 1,000 to 1,500 bluegill fingerlings per acre along with 75 to 125 largemouth bass fingerlings per acre. However, the ideal number to be stocked depends on the fertility of the pond.

Unfortunately, this combination can easily become unbalanced, typically with the bluegills becoming too numerous. The only possible solution to this is the stocking of additional bass or the removal of a portion of the bluegills. Fishing should be delayed until pond balance has been achieved. It has been found, in Alabama, that four general stocking combinations will produce satisfactory pond fishing:

1) Fingerling bass + fingerling bluegill in the fall.
2) Fingerling bluegill in fall or winter + 1-inch bass the following spring.
3) Fingerling bluegill in the fall or winter + brood bass (0.5 pound each) in late winter.
4) Brood bluegill + brood bass (0.5 pound each) in winter.

SWINGLE, H. S., E. E. PRATHER, R. ALLISON and E. W. SHELL. 1964. Management techniques for public fishing waters: Control of unbalanced fish population. Dingell-Johnson Project AL F-10-R-05, Job No. 4. Alabama Division of Game and Fish. Auburn, Alabama. 2 p.

SWINGLE, H. S. and E. V. SMITH. 1940. Experiments on the stocking of fish ponds. Transactions of the Annual North American Wildlife Conference 5 : 267-276.

Experiments have been conducted over a 5-year period upon methods of stocking ponds for the most efficient production of freshwater fish. These experiments have been conducted in ponds ranging in size from 0.5 to 12 acres. Ponds were stocked in various ways during the winter or early spring and the results determined, after an interval of one or more years, by draining the ponds and counting and weighing the fish.

Stocking with adult fish (a combination of bluegills, white crappie, yellow bullheads, and largemouth bass) gave extremely poor results. This procedure resulted in overcrowding the pond with some species and in the total failure of other to reproduce.

Stocking ponds only with bluegill bream fingerlings resulted in rapid growth of the bream until spawning occurred. Growth then ceased entirely, due to the increased competition for food by the thousands of small fish produced. Very few fish ever reach a legal size in ponds stocked in this manner.

Stocking ponds with various combinations of bluegill bream and white crappie gave better results, but usually resulted in ponds overstocked with either bream, or crappie, or both.

Stocking ponds with a combination of bluegill bream fingerlings and largemouth black bass gave the best results, measured both by the growth of bream and bass. In these ponds, the bass had reduced the numbers of small bream and small bass, leaving approximately the right numbers for rapid growth. Good results were secured only by the addition of the correct numbers of fingerlings of both species; the basis upon which these numbers are calculated is given.

Properly stocked ponds provide good fishing within less than a year, while improperly stocked ponds have required as long as five or more years to reach this condition.

SWINGLE, H. S. and E. V. SMITH. 1943. Effect of management practices on the catch in a 12-acre pond during a 10-year period. Transactions of the North American Wildlife Conference 8 : 141-155.

The effect of various management practices on the catch of fish in a 12.5-acre pond is given for the years 1932 to 1942. The discussion of these results is divided into two periods. The first period extended from 1932 to 1938 and during this time no information, based on experimental evidence, was available on methods of pond management. This period ended when a heavy flood washed out the dam and drained the pond. The second period followed the repair of the dam and extended from 1938 to 1942. During this time principles and methods of pond management were being rapidly developed by experimental procedure. As new information became available, mistakes in the management of this pond were corrected and better methods were used. The differences in the results during these two periods are due entirely to the application of methods developed by this experimental work.

During the first period, stocking in the spring with adult bluegill bream and shellcracker bream, without at the same time stocking with carnivorous fish, resulted in the pond becoming badly overcrowded with bream the first summer. The pond remained overcrowded with bream during the remainder of this period, although some reached legal size each year. Six months after the original stocking with bream, 150 fingerling largemouth bass were added; 6 months later 8 adult bass, and 18 months later 100 fingerling bass were also stocked. These bass were unable to produce young in this pond during the five-year period because the overcrowded bluegills ate their eggs. Furthermore, since insufficient bass were added to utilize the available crop of small fish, only 3 largemouth bass were caught. Stocking with white crappie instead improved the fishing somewhat, but over two-thirds of the entire weight of fish removed from the pond consisted of red-eye bass and yellow bullheads, species which entered the pond from the stream. The total pounds of fish caught per acre for each year of the first period were 28, 19, 34, 20, and 22.

At the start of the second period it was decided to flood a luxurious growth of jungle-rice (*Echinochloa colona*) which had grown on the pond bottom while the dam was being repaired. These decaying weeds furnished an abundance of food in the pond from August, when flooding began, to December 1938. Their use for this purpose, however, was found to be a mistake since the lignified stems were resistant to decomposition and wherever present interfered greatly with fishing during the next two years. By 1939, experiments had proved that largemouth black bass must be used to balance ponds containing bream and crappie. Experiments had also shown that good bass fishing would result and the bass would be able to reproduce only if a sufficient number of bass were stocked to correct the overcrowded condition. Bass were therefore added in 1940 and 1941. They reproduced successfully in the pond in 1942, indicating that the pond was then in proper balance. The pounds of fish caught per acre for the last five months of 1938 and for each succeeding year of the second period were 33.5, 110, 172, and 274.

SWINGLE, H. S. and E. V. SMITH. 1947. Management of farm fish ponds. Bulletin 254. Alabama Polytechnic Institute. 30 p.

SZALAI, A. J. and T. A. DICK. 1998. *Proteocephalus ambloplitis* and *Contracaecum* spp. from largemouth bass (*Micropterus salmoides*) stocked into Boundary Reservoir, Saskatchewan. Journal of Parasitology 76(4) : 598-601.

Nonresident (introduced) largemouth bass (*Micropterus salmoides*) from Boundary Reservoir, Saskatchewan were examined for helminths. Four species of parasites were found (*Diplostomum* sp., *Proteocephalus ambloplitis*, *Pomphorhynchus bulbocoli*, and *Contracaecum* sp.). *Contracaecum* sp. larvae were absent in age-0 and age-1 bass, but prevalence and mean intensity increased with age for bass age-2 or older. Similarly, the prevalence and mean intensity of *P. ambloplitis* plerocercoids in bass were low until age-2; older bass harbored significantly more plerocercoids. Analysis of stomach contents indicates that this pattern of recruitment for *Contracaecum* sp. and *P. ambloplitis* is probably due to increased feeding by largemouth bass on aquatic insects and cannibalism after age-2, respectively. Although *Contracaecum* sp. may have been established in the reservoir prior to the introduction of bass, we are certain that *P. ambloplitis* was introduced via stocking with infected fingerlings.

TAUB, S. H. 1972. Exploitation of crayfish by largemouth bass in a small Ohio pond. Progressive Fish Culturist 34(1) : 55-58.

The numerous problems associated with small pond management for largemouth bass (*Micropterus salmoides*) are a matter of record. Largemouth bass ponds fail mainly because of: (1) an overharvest of bass and, (2) an underharvest of prey fish species. The purpose of this study was to evaluate the success of largemouth bass using burrowing crayfish for forage instead of fish, in a small Ohio pond. Criteria established for success were: (1) growth rate of bass, and (2) maintenance of the population level of crayfish.

A total of 770 largemouth bass fingerlings were stocked on October 9, 1967, in a one hectare pond. These bass were young-of-the-year raised at the Hebron National Fish Hatchery in Ohio. A sample of approximately 30 bass was taken each year during the summer and fall for 2 years following their initial introduction. The stomachs were removed and the contents examined for crayfish.

The Schnabel method revealed an estimated population of 37,000 crayfish, species *Cambarus diogenes*, with confidence limits of 35,000 to 39,000 at the 95% confidence level.

The percent frequency of occurrence of crayfish in bass stomachs revealed intensive use (69%) for the first year after bass introduction, and moderate use (54%) 2 years after introduction. Bass growth was rapid during the first year of the study with a gradual decline during the second year.

It is not possible to isolate all of the many dependent factors from a complex interacting aquatic system, however, inferences from the study include:

1) Largemouth bass grew rapidly utilizing crayfish as a principal source of forage when the crayfish population was relatively large, yet it was not a satisfactory substitute for forage fish as its population could not be sustained at a level necessary to feed the bass;
2) And largemouth bass were effective at controlling the population of *Cambarus diogenes*.

TERRE, D. R., S. J. MAGNELIA and M. J. RYAN. 1993. Year class contribution of genetically marked Florida x northern largemouth bass stocked in three Texas reservoirs. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 47 : 622-632.

Percent year class contribution was evaluated for genetically marked Florida largemouth bass (*Micropterus salmoides floridanus*) x northern largemouth bass (*M. s. salmoides*) stocked in three Texas reservoirs. Electrofishing catch rate and size structure data were used to determine population characteristics of each study reservoir. Stocking rates of genetically marked fingerlings ranged from 30 to 200 fish/ha. Post-stocking collections were made by electrofishing at permanent stations over a four year period. Town Reservoir, which had the highest largemouth densities and recruitment had the lowest percent contribution by stocked fish (1-7%). Conversely, Meredith and Braunig reservoirs, which had lower largemouth bass densities and historical recruitment and reproduction problems, respectively, had relatively high returns (41-45%). Year class strengths at the time of stocking influenced success at Town and Braunig reservoirs. The percent contribution of stocked fish was greatest during years with relatively weak year classes. In Town Reservoir, offspring of stocked bass contributed significantly to subsequent year classes (5-13%). These fish appeared to change the genetic structure of this population by increasing age-0 hybrid bass phenotypes (F_1 and F_x) and decreasing the northern bass phenotype. Results suggest supplemental largemouth bass stocking success may be influenced by the density and recruitment characteristics of the native population. However, due to sample size limitations a strict interpretation of these results would be inappropriate. Similar studies, with increased sampling effort, may better define the role of density and recruitment on stocking success.

TETZLAFF, B. L. 1989. Illinois largemouth bass research: Production and survival of hatchery-reared largemouth bass. Dingell-Johnson Project IL F-58-R, Jobs 101.1-1.1.4, Final Report. Illinois Department of Conservation. Springfield, Illinois. 36 p.

Overall study objectives were to determine factors (e. g., water temperature, photoperiod, hormonal injection, and daily removal of eggs) affecting largemouth bass reproduction in intensive spawning condition, and if the survival of intensively-reared bass fingerlings is as good as that of those reared on natural food.

THOMAS, C. D. 2000. Site-specific contribution of stocked largemouth bass fingerlings to age-0 year-class strength in Currituck Sound, North Carolina. Presented at the 2000 Annual Meeting of the North Carolina Chapter of the American Fisheries Society. (Abstract only)

During June 1996 and 1997, 12,000 microtagged largemouth bass (*Micropterus salmoides*) fingerlings were stocked along shoreline areas of Currituck Sound. Study objectives were to measure the contribution of stocked fingerlings to localized age-0 largemouth bass populations, and to examine the potential effects of salinity on fingerling survival and site fidelity. A total of 55 tagged fish were recaptured during electrofishing sampling between July 1996 and April 1998. Recapture:capture ratios and catch rates of tagged and wild fingerlings suggest the 1996 stocking in 1 of the 4 study sites was successful. Although microtagged fingerlings were recaptured from the other 3 sites during the study period, their contribution to localized age-0 populations was minimal. Tagged fingerlings were collected at salinities as high as 5.5 g/L. No relationship between salinity and capture of tagged fingerlings was observed; however, salinities during the study period remained similar among sites, and rarely exceeded 2.5 g/L. Recapture of 2 tagged fingerlings outside their release areas indicated movement of at least 400 m. Growth of wild and tagged fish was comparable throughout the study period. Analyses of wild fingerling abundance data suggests full recruitment to our boat-mounted electrofishing gear did not occur until fish were > 140 mm total length.

THURSTON, L. D. W. 1976. Largemouth bass introductions to Mead Lake, Monteith Township. File Report. Ontario Ministry of Natural Resources. Parry Sound, Ontario. 1 p.

THURSTON, L. D. W. 1978. Largemouth bass introductions in the Parry Sound District, 1976-1978. File Report. Ontario Ministry of Natural Resources. Parry Sound, Ontario. 3 p.

Between 1976 and 1978, hundreds of adult largemouth bass were transferred from one lake to another in the Parry Sound District. Neville, Cole, Pender, Simmes and Martin lakes were the donor bodies as well as Nogies Creek. Various methods were used to plant the fish into Axe, Mowat, Dinner, Imrie, Manitouwaba, Horn and Mead lakes. Transport by truck was adequate for most areas, however, there was also need for helicopter and packsack transport in order to plant fish in appropriate regions of the lake.

TIDWELL, J. H., S. D. COYLE and C. D. WEBSTER. 1998. Effects of stocking density on third year growth of largemouth bass (*Micropterus salmoides*) fed prepared diets in ponds. Journal of Applied Aquaculture 8(4) : 39-45.

TIDWELL, J. H., C. D. WEBSTER, S. D. COYLE and G. SCHULMEISTER. 1998. Effect of stocking density on growth and water quality for largemouth bass (*Micropterus*

***salmoides*) growout in ponds. Journal of the World Aquaculture Society 29(1) : 79-83.**

TOTH, G. 1983. Largemouth and smallmouth bass. p. 271-324 *In* G. Watson, J. Grant and A. Wheatley [eds.]. Beyond the Rainbow: Alternative Species for Commercial Aquaculture in Ontario. Owen Sound, Ontario.

The largemouth bass (*Micropterus salmoides salmoides*) and the smallmouth bass (*Micropterus dolomieui dolomieui*) are two of the major game fish species of North America and are indigenous to Ontario. Their rapid growth rates and tolerance of warm water have made them popular species for stocking farm ponds and public fishing waters. It is probable that the demand for warmwater species such as bass will continue. Many bass hatcheries exist in the United States and Canada. Extensive bass culture has been practised for the past century, but intensive culture has only become possible during the past two decades with the development of suitable artificial feeds. These diets have allowed bass to be reared to the adult stage. Construction of new ponds is continuing in rural areas, although many of these smaller ponds are inappropriate for stocking with the popular trout species because of water quality characteristics. A demand may increase for warmwater species such as bass to fill this stocking need. A new market may also develop as the government transfers its rearing programs to the private sector for stocking of public water. Although current laws in Ontario restrict the propagation of bass to stocking purposes only, a change in legislation to allow culturing these species for human consumption may result in their being reared as a food fish, as is done in some parts of the United States.

TOOTS, H. 1970. Exotic fishes in Rhodesia. Rhodesia Agriculture Journal 67(4) : 1-6.

TRAVIS, J. M. 1968. Experimental stocking of largemouth bass and threadfin shad in ponds. Dingell-Johnson Project TX F-R-6-15, Job No. 6, Report. Texas Parks and Wildlife Department. Austin, Texas. 9 p.

TUCKER, H., W. E. LYNCH and D. L. JOHNSON. 2000. Effect of prey availability and reservoir bacteria over-winter survival, growth and condition of young-of-year largemouth bass. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

Juvenile largemouth bass suffer high mortality during their first winter of life, potentially affecting recruitment of the species. Low prey availability, small individual size, and depletion of energy reserves all likely contribute to this high mortality. In addition, the combination of these stressors, low temperatures and water quality may reduce immunity to disease. One experiment attempted to determine effects of prey availability and water quality on survival of young-of-year largemouth bass by keeping largemouth bass in either conditioned water or reservoir water. The fish were then exposed to one of the following feeding regimes: nourishment through winter, nourishment only through the end of November, or no nourishment through winter. Starved largemouth bass in reservoir water experienced nearly 90% mortality, while the same group in tap water experienced 100% survival. A second experiment assessed the effect of reservoir bacteria to overwintering largemouth bass in combination with prey availability by keeping fed and non-fed groups of fish in reservoir water, tap water with reservoir bacteria, or tap water. Only starved fish housed in reservoir water exhibited size-related mortality. Mortality rates did not differ significantly among water treatments. Individual size and prey availability likely affect survival of largemouth bass more than bacterial disease.

TURMAN, D. and D. C. DENNIS. 1998. Historical review of largemouth bass minimum length and slot limits on Lake Columbia, Arkansas with management implications. Presented at the Arkansas, Kansas and Oklahoma Chapters of the American Fisheries Society Joint Annual Meeting, February 10-12, 1998, Fayetteville, Arkansas. (Abstract only)

Lake Columbia is a 1214 ha water municipality reservoir in South-central Arkansas that was impounded in March 1987 and stocked with 75-100 mm (3-4 in) fingerling Florida subspecies largemouth bass (*Micropterus salmoides floridanus*). A 300 mm (12 in) minimum length limit was imposed to protect the bass population and to insure an adequate spawn. Growth of bass was so rapid that it was necessary to increase the length limit to 375 mm (15 in) on April 1, 1988 in order to protect the bass through their first spawning season. In the Fall of 1989, electrofishing data indicated a large proportion of bass between 225-275 mm (9-11 in). On February 1, 1990 the 375 mm (15 in) minimum length limit was removed and a 325-400 mm (13-16 in) slot limit was implemented to reduce the number of 225-275 mm (9-11 in) largemouth bass. By Spring of 1991, the slot limit had successfully reduced the proportion of bass > 300 mm (> 12 in) and helped shift the population into the protected 325-400 mm (13-16 in) slot. By 1992, the bass population had clearly entered the slot and there was evidence of good numbers of bass exceeding 400 mm (16 in). In 1993, composite analyses suggested that largemouth bass < 400 mm (16 in) were not above the 1.0 ppm FDA action level for mercury, but largemouth bass > 400 mm (16 in) were generally above 1.0 ppm. This new information conflicted with the lake's current management slot and the Arkansas Health Departments' recommended consumption advisory. In January 1994, Lake Columbia was designated a Trophy Bass Lake which required a 400-525 mm (16-21 in) protective slot and a reduced creel of four fish of which only one can be over 525 mm (21 in). The designation as a trophy bass lake with a 400-525 mm (16-21 in) slot allows for the management of a quality bass fishery while also addressing human consumption of largemouth bass. The 400-525 mm (16-21 in) Trophy Bass Slot currently remains in place and has been very successful in allowing for the consumption of bass that are safe to eat while at the same time developing Lake Columbia into an outstanding trophy largemouth bass fishery. The key to achieving management objectives when using minimum length or protective slot limits, is to observe the population carefully and consistently and be able to recognize changes that take place in the population structure so the appropriate changes or corrections in management can be made.

TURNER, J. L. 1963. A study of a fish population of an artificial lake in central Missouri with emphasis on *Micropterus salmoides*. M. Sc. Thesis, University of Missouri. Columbus, Missouri. 59 p.

TYSON, O. T. 1907. Introduction of the black bass into the Ohio and the Potomac. Maryland Historical Magazine 2 : 14-16.

VANDER ZANDEN, M. J. and J. B. RASMUSSEN. 2000. Consequences of smallmouth bass and rock bass introductions in Ontario lakes: A food web approach. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

Both smallmouth bass and rock bass have expanded their range across the landscape due to human introductions and dispersal; however, the implications of these introductions are poorly known. Here, we examine the food web consequences of smallmouth and rock bass introductions into lakes of central Ontario. Invaded lakes had greatly reduced littoral prey fish diversity and abundance compared to uninvaded lakes. Stable isotope ratios of carbon (d13C) and nitrogen (d15N) demonstrated that the native lake trout shifted to invertebrates (from their preferred fish diet) in the presence of bass. Comparison of pre- and post-invasion food webs of two recently invaded lakes showed that invasion was followed by massive declines in littoral prey fish abundance and the trophic position of lake trout, evidence that bass introductions affect lake trout populations. Further food web analysis indicated that lakes in which lake trout rely on littoral prey fish will be most impacted by bass invasion, while lake trout supported by the pelagic prey fish will be little affected by bass introduction. Thus, information on food web structure can be used to identify the most important areas for preventing further introductions of bass.

VIRGINIA COMMISSION OF GAME AND INLAND FISHERIES. 1957. Evaluation of year round bass fishing. Dingell-Johnson Project VA F-5-R-3, Job No. 1. Virginia Commission of Game and Inland Fisheries. Richmond, Virginia. 8 p.

WALDEN, F. A. 1953. Management of the fishery of the Muskoka River System: A biological survey of Heney's Lake, McLean Township. Parry Sound Forest District Biological Studies No. 7. Ontario Department of Lands and Forests. Parry Sound, Ontario. 8 p.

Heney's Lake has an area of 50 acres and appears to be a less than fertile lake. Native species include the white sucker, yellow perch, pumpkinseed sunfish, creek northern chub and an unidentified species of minnow. In 1952 thirty-one parent smallmouth bass were stocked into the lake. It is recommended that stocking be continued at a rate of 500 fingerling bass per year should continue for four more years to supplement the original plant.

WALLIS, O. L. 1950. The status of the fish fauna of the Lake Mead National Recreational Area, Arizona-Nevada. Transactions of the American Fisheries Society 80 : 84-92.

The Colorado River flows for nearly 225 miles through the Lake Mead Recreational Area, Arizona-Nevada. Its character has been controlled and changed as a result of construction of Hoover and Davis Dams. The composition of the fish fauna has changed, also. There are now known from the area 3 native and 11 exotic species. Six additional fishes native to the Colorado River Basin and two other alien forms may occur.

The largemouth black bass (*Micropterus salmoides*) was first extensively stocked in the Lake Mead National Recreational Area in July of 1935. According to National Park Service records 466,000 bass fingerlings were planted from 1935 to 1940 and today the largemouth is the principle sportfish of Lake Mead. There are no further introductions planned as the bass population is supporting itself adequately and any further stocking is discouraged.

WEATHERS, K. C., M. J. NEWMAN and F. HAMILTON. 1994. Evaluation of the survival of largemouth bass (*Micropterus salmoides*) following relocation in state-owned lakes: A final report for state lake fisheries research. Alabama Game and Fish Division. Auburn, Alabama. 34 p.

WEAVER, O. R. 1979. Evaluation of stocking largemouth bass fingerlings in Lake Blackshear. Georgia Department of Natural Resources. Atlanta, Georgia.

Early spawned largemouth bass (*Micropterus salmoides*) fingerlings were stocked into Lake Blackshear, Georgia, in 1974 and 1975. The stockings of 20 and 22 fish per hectare, respectively, were made in an effort to increase year class strength and improve fishing. Micromagnetic wire tags were used to identify the stocked fish, and cove rotenone sampling and a creel survey were used to evaluate the success of the stockings over a four year period.

No evidence of changes were found in the bass population, or harvest which could be attributed to the bass stockings. No significant difference could be detected at the 0.05 level of probability between bass "fished for" catch rates before (1969-71 and 1974-76) and after (1977) the stocked bass entered the creel. The overall quality of fishing in Lake Blackshear was equal to or slightly better than that found in other Georgia reservoirs during 1976 and 1977.

Tag returns suggested that the proportion of the 1974 year class comprised of stocked fish remained relatively constant from 1974 to 1977. Bass stocked in 1975 survived but survival estimates were inconclusive. Stocked bass were estimated to comprise 10.6% of the legal size fish in the population three years after the initial stockings. However, there was no indication that they contributed to an increase in the number of bass available to the creel.

WEBSTER, D. A. 1950. Fishery research program at Cornell University. Progressive Fish Culturist 12(2) : 77-80.

Since 1941 studies have been conducted on smallmouth bass in the portion of Cayuga Lake known as Flat Rock. The tagging and release of wild bass as well as the fin-clipping of 44,000 hatchery-reared fingerlings has occurred to date. These released fish are currently contributing to the angler's catch and are supplementing the population structure through various year classes.

WEEK, L. E. 1984. Age and growth of Florida largemouth bass (*Micropterus salmoides floridanus)* in Hidden Valley Reservoir, Lake County, California. California Fish and Game 70(1) : 59-60.

Improved angling attributed to introductions of Florida largemouth bass have prompted further introductions to lakes and reservoirs at more northern latitudes. Hidden Valley Lake, Lake County, is a 43-ha impoundment at an elevation of 305 m. It was devoid of bass until 1969 when Florida largemouth bass were introduced. A study was conducted to determine if the growth and longevity of Florida largemouth bass would be duplicated at a more northern latitude.

Scale annuli and fork lengths were used to age fish taken from Hidden Valley Reservoir and to determine the growth rate of the bass. The rate was found to be similar to the Florida bass growth recorded at El Capitan Reservoir, San Diego County (Bottroff and Lembeck 1978). In other areas such as Clear Lake Florida bass introductions have also produced large specimens. Their growth rates exceed those of northern largemouth bass in the same or similar waters, suggesting that the growth of the Florida largemouth is genetically controlled. On this basis it appears to be a desirable addition to the warmwater fish fauna of selected reservoirs in central and northern California. However, other attributes of Florida bass, such as low vulnerability to angling, their impact on forage species and other warmwater gamefish, and reported low tolerance to colder water temperatures should be considered when selecting additional waters.

WEIDEL, B. C., D. C. JOSEPHSON and C. C. KRUEGER. 2000. Diet and prey of naturalized smallmouth bass in an oligotrophic Adirondack lake. Journal of Freshwater Ecology 15(3) : 411-420.

Smallmouth bass (*Micropterus dolomieu*) introduced nearly fifty years ago have established a permanent population in Little Moose Lake, NY. Over 500 smallmouth bass were collected by angling in the littoral zone from June to August. Gut contents were compared for differences based on length of bass, date of capture, and substrate type where each fish was caught. Crayfish were the most frequent diet item and made up the largest percent composition by number. The average number of crayfish per stomach increased with bass length as did the number of fish per stomach. Crayfish, *Ephemeroptera*, *Odonata*, and fish made up 77% of the total number of diet items, excluding zooplankton. A noticeable diet shift from smaller diet items (*Ephemeroptera*) to larger ones (crayfish and fish) occurred when smallmouth bass approached 150 mm. A high amount of diet overlap occurred between bass caught over different substrate types and among size classes. Smallmouth bass in Little Moose Lake were opportunistic feeders, using benthic, terrestrial, and pelagic littoral zone food resources. The most likely processes by which smallmouth bass affect salmonid and native fishes in Little Moose Lake are competition for food resources and predation.

WEIR, J. C. Undated. Game fish management: Sanctuaries and restocking. File Report. Ontario Ministry of Natural Resources. Lindsay, Ontario. 5 p.

The planting of hatchery-reared gamefish is discussed and guidelines are given for specific species.

The smallmouth bass should be distributed along rocky or gravel shores in water which is at minimum 3-4 feet deep. These areas should have cover such as large boulders, logs or stumps. Sandy areas and open areas should be avoided as much as possible to increase chances of survival.

The largemouth bass preferred weedy and muddy bottoms along marsh-like shores. As with the smallmouth bass the area in which this species is planted should be predator-free and should have cover nearby such as fallen trees and wharfs.

WELCOMME, R. L. 1988. International introductions of inland aquatic species. Fisheries Technical Paper 294. Food and Agriculture Organization of the United Nations. Rome, Italy. 318 p.

The native range of the smallmouth bass (*Micropterus dolomieui*) is the northeastern United States and Canada, however, it has also been introduced into many European and African countries for sportfishing purposes.

Its introduction into South Africa has demonstrated a large amount of success in areas of the Western Cape where precipitation is high during the winter months. The fish were initially stocked in lakes and rivers when imported from the United States in 1937. South Africa has since shipped numbers of the smallmouth bass to Swaziland and Zimbabwe for sportfishing purposes.

The majority of the European introductions originated from the United States and met with varying success, resulting in small, scattered populations. Imports from California led to the establishment of smallmouth bass populations in Hawaiian streams and on Kaui and Oahu Islands. There are currently a few populations in reservoirs of northern Mexico and the populations are self-sustaining in Belize.

The largemouth bass (*Micropterus salmoides*) is native to the eastern and southern United States and northern Mexico, yet it has been transplanted and stocked across North America as well as many other parts of the world. Although the species has been blamed for the disappearance of native species, it is still favored as a sportfish.

Kenya has benefitted from bass imported in 1929 from the United States, for sportfishing. Lake Naivasha now has a successful largemouth bass population. It is prolific in South Africa and appears in the high altitude waters of some other African countries. The largemouth bass is currently a popular sportfish in (the former) Yugoslavia. Like the smallmouth bass, it has established itself in Hawaii and on islands Oahu and Kamai.

The largemouth bass has also had negative impacts in some countries. In Italy, the species has caused a decrease in native populations of *Alburnus alborellus*, *Esox lucius* and *Perca fluviatilis*, as well as the introduced species of *Lepomis*. The local fisheries in Guatemala have also been destroyed.

WENGER, A. G. 1967. Fisheries investigations and surveys of Region 4A: A review of literature on stocking largemouth bass with other species. Texas Parks and Wildlife Department. Austin, Texas. 26 p.

WENGER, A. 1968. Bass stocking techniques. Dingell-Johnson Project TX F-12-R-13, Job No. 4-A. Texas Parks and Wildlife. Austin, Texas. 19 p.

WENGER, A. 1972. Review of the literature concerning largemouth bass stocking techniques. Technical Series 13. Texas Parks and Wildlife Department. Austin, Texas. 40 p.

WESTERS, H. 1963. An evaluation of population estimate procedures in two ponds, containing only largemouth bass (*Micropterus salmoides*). M. Sc. Thesis, University of Michigan. Ann Arbor, Michigan.

WHEELER, A. and P. S. MAITLAND. 1973. The scarcer freshwater fishes of the British Isles. I. Introduced species. Journal of Fish Biology 5 : 49-68.

The purpose of this paper is to give an account of some of the scarcer species of freshwater fish occurring in the British Isles, with special reference to their origin, past dispersion and present distribution and status.

Many of the introduced species exist only in small, isolated populations. The largemouth bass (*Micropterus salmoides*) was first introduced into Europe by way of Germany and Holland in 1883 and by 1890 there existed a breeding population in a pond near Versailles. Currently, it is established in numerous rivers in the southern and eastern regions of France.

There appear to have been many introductions of the largemouth bass in Great Britain, yet there are currently few recognized populations. The Norwich Angling Club is suspected of initiating the first introduction of largemouth bass by stocking 250 young fish into a 3-acre lake in 1927. There is a possibility that the introduction took place much earlier, in 1881/1882 to Loch Baa. Regardless of which planting came first, the status of the largemouth in Britain is uncertain, although it is known that a colony located in an abandoned clay pit at Wareham still exists.

The smallmouth bass (*Micropterus dolomieui*) appears to have had worse luck in establishing itself than the largemouth bass. It has an extensive history of introduction to Europe, yet it has not become abundant anywhere. However, it is present in a few isolated French lakes and a tributary of the Rivière Meuse. The first recorded introduction into Britain occurred in December, 1878, when bass were transplanted from Lake Rosseau, Ontario, to bodies of water located at Eynsham Hall, Oxford and Dunrobin Castle, Sunderland. Also during 1878 and 1879, a large number of smallmouth bass were released into Whitewater Lake. In the years that followed there occurred other, limited, plantings of the bass. At the present time, the authors are unaware of any established population of the smallmouth in the British Isles.

WHITMORE, D. H. 1983. Introgressive hybridization of smallmouth bass (*Micropterus dolomieui*) and Guadalupe bass (*M. treculi*). Copeia 1983 : 672-679.

The introduction of smallmouth bass (*Micropterus dolomieui*) into the range of the endemic Guadalupe bass (*M. treculi*) on the Edwards Plateau in southcentral Texas has resulted in hybridization between these species. Sympatric populations of smallmouth bass and Guadalupe bass from two discrete locations on the

Edwards Plateau were analyzed on the basis of biochemical genetics and meristics. Electrophoretic and meristic evidence revealed no interspecific hybrids in Lake Travis. It appears that smallmouth bass have not adapted well in this lake, perhaps contributing to the lack of genetic exchange with Guadalupe bass. In contrast, the Canyon Lake populations are actively interbreeding, and diagnostic allozyme loci clearly revealed genetic introgression between these two species. Genetic analysis proved to be a more sensitive tool for detecting F_2 or backcross individuals than the meristic index. The genetic integrity of Guadalupe bass appears to be seriously threatened in at least part of its highly restricted range.

WHITMORE, D. H. and W. BUTLER. 1982. Interspecific hybridization of smallmouth bass and Guadalupe bass (*Micropterus*): Evidence based on biochemical genetic and morphological analyses. Southwestern Naturalist 27 : 99-106.

WHITTIER, T. R. and T. M. KINCAID. 1999. Introduced fish in northeastern USA lakes: Regional extent, dominance, and effect on native species richness. Transactions of the American Fisheries Society 128(5) : 769-783.

We assessed the effects of nonnative fish on native fish biodiversity, using assemblage data collected during 1991-1996 from 203 randomly selected lakes in the northeastern USA by the Environmental Monitoring and Assessment Program (EMAP) of the U. S. Environmental Protection Agency. An estimated 74% (±17.6%, 95% confidence interval) of the region's 10,608 lakes between 1 and 10,000 ha contain at least one introduced species. Based on our samples nonnative individuals outnumbered natives in an estimated 31.5% (±11%) of lakes. Regression models indicated that native, introduced, and total species richness were associated with lake surface area, elevation, and lake depth ($0.31 \leq R^2 \leq 0.81$). The intensity of human disturbance in the watershed was positively associated with introduced species richness but not associated with native species richness. The number of non-native species was a significant variable in the native-species regression models for the entire Northeast and for only one of five subregions, the Northeast Coastal Zone ecoregion. Of the types of fishes that have been introduced, littoral predators – primarily *Micropterus* – appeared to be the greatest negative effect on native species richness. Small or soft-finned species appeared to be the least tolerant of these introduced predators. Native brook trout and minnow assemblages, typical of northern lakes in the Northeast but now rare in the Adirondacks, appeared to be at the greatest risk from continued introductions in northeastern New England. Current among-lake (ß) species diversity was associated more with regional diversity of lake types than with extent or dominance of nonnative species. Without quantitative historical data, it was not possible to demonstrate a homogenizing effect of introductions on lake fish assemblages.

WILLIAMS, J., S. KAZIANIS and R. B. WALTER. 1996. The use of random amplified polymorphic DNA (RAPD) to identify largemouth bass subspecies and their intergrades. Presented at the 1996 Meeting of the Texas Chapter of the American Fisheries Society. (Abstract only)

Texas Parks and Wildlife Department (TPWD) began producing and stocking Florida largemouth bass (*Micropterus salmoides floridanus*) in the early 1970s to help support the largemouth bass recreational fishery. To ensure that only pure Florida largemouth bass are stocked, potential broodstock are evaluated using agarose gel electrophoresis, followed by histochemical staining of two diagnostic isozymes to identify those with pure Florida largemouth bass genotype. A limitation of this technique is that later generation or backcross intergrades can exhibit a wide variety of genotypes and may not be distinguishable from pure Florida parental types.

Random amplified polymorphic DNA (RAPD) is a genetic technique based upon the amplification of genomic DNA with a single primer of arbitrary sequence. These primers detect polymorphisms in DNA sequence that can be used as genetic markers and are inherited in a Mendelian fashion. The rationale for

RAPD PCR is that at low PCR stringency conditions (i.e. low annealing temperature and/or high magnesium concentrations), a primer is likely to find many sequences with the template DNA, to which it can anneal with mismatches. If there is a high frequency of these sequences in the template DNA, it is likely that pairs of these sequences will be arranged inversely to one another and within about two kilobases of each other. Given this, PCR will give amplification of these fragments which can vary in size when different species, subspecies, etc. are analyzed. Since there are an unlimited number of primers that can be used, the number of polymorphisms that can be identified and used for subspecies identification are also unlimited. This gives RAPD PCR a distinct advantage over agarose gel electrophoresis when only two loci are examined.

Nineteen 25-30-mer primers were screened for polymorphisms and five were chosen for further evaluation. Twenty fish from each group – Florida-wild type, Northern-wild type, and fish of unknown origin (F_x) – were analyzed using RAPD PCR. First generation intergrades were produced and used to detect Mendelian inheritance of polymorphic bands. Evidence is presented for the usefulness of RAPD PCR in distinguishing between the different subspecies and intergrades of largemouth bass. Because of the increased sensitivity and the relative ease of this technique, it is shown to be far superior to agarose gel electrophoresis for broodstock evaluation.

WILLIAMSON, J. H. and G. J. CARMICHAEL. 1987. Stress-mortality differences between intensively- and extensively-reared largemouth bass. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 41 : 145-149.

Stress due to confinement in a net caused higher mortalities in largemouth bass (*Micropterus salmoides salmoides*) which were extensively-reared in ponds on zooplankton and other invertebrates than in those which were intensively-reared in raceways on pelleted food. Fish that were intensively-reared weighed more than the fish reared in ponds, although both groups were sorted with the same bar-grader. Intensively-reared fish exhibited 3% and 9% mortalities after 13- and 16-hour net confinements, respectively, compared to 34% and 38% for those fish reared in ponds. Fish reared intensively may be better able to tolerate the stress of harvest, handling and transportation than extensively-reared fish.

WILLIS, D. W., D. K. RIECKE and J. GOUDZWAARD. 1987. Stocking advanced sizes of largemouth bass into a recruitment limited bass population at Perry Reservoir, Kansas. Dingell-Johnson Federal Aid Project KAN FW-9-P-3, Studies 4&5. Kansas Fish and Game Commission. Emporia, Kansas.

WILMOT, S. 1877. Report of the Commissioner of Fisheries for the year ending 31st December, 1876. p. 369-370 *In* Supplement No. 4 to the 9th Annual Report of the Minister of Marine and Fisheries for the Year 1876.

Mr. Gilchrist, the officer in charge at Rice Lake, proposed an experiment which would see mature, nearly spawned adults placed into a new body of water to reproduce. Forty black bass were taken from Rice Lake and placed into a pond to spawn. The surviving fry were then returned to Rice Lake and Mr. Gilchrist considered the experiment a success.

WINGATE, P. J. 1991. United State's view and regulations on fish introductions. Canadian Journal of Fisheries and Aquatic Sciences 48(Supplement 1) : 167-170.

A survey of the policy of 50 U. S. states on transplanted fish introductions and stocking fish of different genetic strains indicates that all 39 responding states control exotic introductions. While 67% of the responding states restrict in-state movement of fish species, more attention is being given to restricting in-state strain movement. More needs to be done. Native species are stocked on top of reproducing populations and moved among watersheds; exotic species are introduced. In some cases, these stockings have appeared to benefit all interested parties, while in other circumstances exotics have totally disrupted ecosystems and become pests. These introductions and stockings are a combination of the fish being available, misunderstanding by managers of possible effects, and strong political pressure to satisfy anglers in more and more waters. Many times, little attention is given to the effect of these introductions on the native biota and fauna as it is perceived that stocking fish is a good thing. It is not until problems develop or anglers want another species added that the wisdom or success of these stockings is questioned. Minnesota's policy is that fish are not moved between watersheds until genetic similarities of the various species in the different watersheds are demonstrated.

Currently, Maryland is the only responding state which has laws concerning fish movement based on genetics. Many states restrict in-state movement of fish. The transfer of largemouth bass is restricted in Illinois, Indiana and Minnesota, while that of the smallmouth bass is restricted in Minnesota and Utah.

WINGATE, P. J. and M. McINERNY. 1997. The use of genetics in developing stocking strategies in Minnesota waters. p. 389 *In* the 59th Midwest Fish and Wildlife Conference, December 7-10, 1997, Milwaukee, Wisconsin. (Abstract only)

In the past, fish biologists and managers seldom considered the genetic integrity of native fish populations in a water body when proposing to stock. This attitude is changing after much genetic and management research has indicated that value of preserving genetic integrity for fish population health. Based on genetics, Minnesota now limits fish stocking through legislation, rules, and policy. Species covered under these applications are walleye, muskellunge, northern pike, channel catfish, smallmouth bass, brook trout, and steelhead. Politics, aquaculturists, and anglers can be an obstacle to prudent genetic management of fish. Following conservation genetic principles is a critical part of stocking decisions, otherwise, we increase the risk of altering native fish populations.

WISCONSIN BUREAU OF FISHERIES MANAGEMENT AND HABITAT PROTECTION. 1999. An evaluation of stocking strategies in Wisconsin with an analysis of projected stocking needs. Wisconsin Department of Natural Resources. Madison, Wisconsin. 38 p.

The stocking of black bass in Wisconsin dates back to the early 1900s when attention was focused on the toll of industrial pollution and loss of habitat on fish populations. A fish hatchery was built at Minoqua in 1903 to propagate black bass for distribution into depleted waters. Until 1940 approximately 1.5 to 2.5 million fry and fingerlings were being allocated to State waters yearly. As evaluations began to show that supplemental/maintenance stocking was contributing little to the fisheries, stocking slowed down. Between 1960 and 1980, lake reclamation projects were prioritized and waters received about 850,000 fry and fingerlings annually. Since this time it has been discovered that stocking waters with smallmouth or largemouth bass populations already established is ineffectual and that positive results typically only occur when the stocked waters are devoid of fish. In the 1980s and 1990s, 500,000 fish were stocked per year, along with 3,400 transfers of yearlings and adults.

Currently, most of the largemouth bass stocking requests originate in the Northern Region of the state, where most lakes being stocked are generally susceptible to winterkill conditions. The waters which are stocked in the West Central areas are done so on a maintenance basis. Smallmouth bass are popular in the Southeast Region to maintain current populations.

The majority of the largemouth bass stocked in Wisconsin are derived from parents who originated in the Mississippi River, while the smallmouth bass are shipped from the State Hatchery program in Illinois.

Because of the shift in support concerning the majority of maintenance stocking practices, it is predicted that there will be a drop in the demand for both largemouth and smallmouth bass (by 33% and 94%, respectively). It is expected that the annual demand for largemouth bass during the next five years will be 150,000 to 200,000 fingerlings.

WRIGHT, B. H. and R. D. SOPUCK. 1979. A history of fish stocking in Northern Manitoba. Manuscript Report 79-6. Manitoba Department of Mines, Natural Resources and Environment. Winnipeg, Manitoba. 70 p.

During the past several decades thousands of fry, fingerlings, yearling and eggs have been planted into northern Manitoba waters to provide better sport fishing. Stocking has mainly been comprised of trout and a few species of salmon, but walleye and smallmouth bass have also been planted.

Athapapuskow Lake was stocked in 1940 and 1941 with 60 and 21 adult fish, respectively. Stocking fish in this lake is considered questionable as the native trout populations are well-established in the lake and it is unlikely that new species will survive to produce a viable population.

In 1962, 71 smallmouth bass adults were planted into Rocky Lake. Not much is known about their survival. In 1976, a specimen was taken by a fisherman and there have been other reports of smallmouth bass being captured. Future stocking is improbable since the lake contains well-established populations of walleye, pike and whitefish.

Two Loon Lake received 10,000 fingerling smallmouth bass in 1976, yet no sampling has been done yet, so the status of the population is not known. No further stocking is planned until the success of this stocking has been evaluated.

In 1971, Two Portage Lake was stocked with 10,000 fingerling smallmouths. The lake has since been removed from the stocking waters list, as there has been an invasion of pike.

WRIGHT, G. L. and G. W. WIGTIL. 1981. Comparisons of growth, survival, and catchability of Florida, northern, and hybrid largemouth bass in a new Oklahoma reservoir. Proceedings of the Annual Conference of Southeastern Association of Fish and Game Commissioners 34 : 31-38.

Florida largemouth bass (*Micropterus salmoides floridanus*), northern largemouth bass (*M. s. salmoides*), and their F_1 hybrid were stocked in a new 420 ha reservoir, and their growth, relative survival and relative catchability were compared. The Florida and hybrid bass were found to achieve the best overall growth by the end of the study period. However, of the 3 strains, Florida bass appeared to have the greatest potential for growth. Hybrid bass suffered less relative mortality than Florida bass, which suffered less than northern bass. Differences in relative catchability were not observed among the three strains of bass.

WURTZ-ARLET, J. 1953. Le black-bass en France: Esquisse monographique (excerpt translated). Progressive Fish Culturist 15(4) : 188-190.

Both the smallmouth and the largemouth black bass were introduced into France from America in 1890. The success of the smallmouth introduction was quite limited as there is no present evidence of its presence in France. However, the largemouth bass has easily acclimated to the waters of France and it is effortlessly propagated in fish hatcheries. The widespread distribution of the largemouth bass is discouraged and at present precautions are taken when introducing an exotic species. Over the years recommendations concerning the introduction of the largemouth have been made:

1) Black bass should never be planted into trout streams. First, its growth would be extremely slow in cold water. In addition, it would be a dangerous competitor of trout, since the food of the two species is closely similar. Introduction of black bass in salmonid streams would be disastrous.
2) The black bass should not be introduced into waters normally inhabited by pike or perch. Placing three predator species together is unwise and it is important to protect native species. The largemouth bass should only be introduced into open waters when all attempts at stabilizing the biological equilibrium of the native species have failed.
3) The most suitable waters for black bass are of moderate temperature, clear, with little or no current.
4) It is best not to make small and scattered local plantings as black bass wander extensively.

WYNNE, M. B. and S. VAN HORN. 1994. Experimental introduction of Florida largemouth bass into Sutton Lake, North Carolina. North Carolina Division of Boating and Inland Fisheries. Raleigh, North Carolina. 10 p.

In 1992 and 1993, largemouth bass were stocked into Sutton Lake, a Carolina Power and Light Company cooling reservoir. Objectives were to compare survival, growth, and condition among Florida largemouth bass, native largemouth bass, and their intergrades. Electrophoretic analysis of native and stocked bass was conducted.

ZEZULA, S. T., T. J. HARTMAN and D. L. JOHNSON. 2000. Stocking largemouth bass in managed wetlands to restructure the fish community. Presented at the Black Bass Symposium, American Fisheries Society Annual Meeting, August 20-24, 2000, St. Louis, Missouri. (Abstract only)

The detrimental effect of benthivorous fish on aquatic vegetation may hinder a wetland's suitability for wildlife. We examined stocking largemouth bass to determine if they could be an effective predator to supplement current wetland management. Largemouth bass were stocked into two managed wetlands in the fall of 1995; a reference wetland remained predator-free. Electrofishing was completed in 1996 and 1997. All sampled fish were counted and measured; largemouth bass were weighed and their diets analyzed. Sustained high growth was such that the bass reproduced at age 1+, and mean length of age 1+ and 2+ bass exceeded any published data from Ohio. Mean W_r routinely exceeded 100 indicating excellent condition. Over the first sample year, bass diet was initially dominated by invertebrates, shifting to fish over time in both year classes. While benthivorous fish made up more than 50% of the catch in the reference wetland, they comprised less than 25% of the experimental wetland catch. Strauss selectivity indices were generally positive for cyprinids, negative for centrarchids, and inconsistent for ictalurids. In the final year, experimental unit turbidity remained extremely low, mean = 3.1 NTU. These data show largemouth bass can serve as an effective biomanipulation tool in complex habitats.

ZOLCYNSKI, S. J. Jr. and W. D. DAVIES. 1976. Growth characteristics of the northern and Florida subspecies of largemouth bass and their hybrid, and a comparison of catchability between the subspecies. Transactions of the American Fisheries Society 105 : 240-243.

Nine 0.04-hectare ponds of the Alabama Agricultural Experiment Station were used to evaluate growth differences among northern largemouth bass (*Micropterus salmoides salmoides*) Florida largemouth bass (*Micropterus salmoides floridanus*) and their hybrid. Salmoides grew faster than *floridanus* or the hybrid during the first summer of life. Since the environments were similar the differences in growth rates were attributed to genetic factors. The first year growth, therefore, is not the factor which contributes to the larger adult size of the Florida largemouth bass. Angling records from four other ponds indicated that *floridanus* was significantly more difficult to catch than *salmoides*. The difference is probably great enough to significantly affect the catch in heavily fished bodies of water.

Acknowledgements

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Subject Key

1.0 General References

- **1.1** Stocking Policies and Management Objectives
- **1.2** Reports of Stocking Projects
- **1.3** Bass Introductions
- **1.4** Bass Stocking Literature Reviews

2.0 Stocking Guidelines and Practices

- **2.1** General
- **2.2** Stocking Frequency
- **2.3** Time of Stocking
- **2.4** Stocking Rates
- **2.5** Age/Size of Fish
- **2.6** Marking Techniques
- **2.7** Diseases and Parasites of Fish
- **2.8** Fish Community in Stocked Waters
- **2.9** Transport and Release Techniques
- **2.10** Stocking Site
- **2.11** Genetic Strain and Subspecies
- **2.12** Physical/Chemical Requirements of Stocked Waters
- **2.13** Stocking Farm Ponds
- **2.14** Stocking Combinations and Ratios
- **2.15** Bass Transfers

3.0 Stocking Assessment

- **3.1** General
- **3.2** Stocking Evaluation Projects
- **3.3** Post-Stocking Survival
- **3.4** Returns to Fishery
- **3.5** Physiology of Stocked Fish
- **3.6** Behavior of Stocked Fish
- **3.7** Growth of Stocked Fish
- **3.8** Movements of Stocked Fish
- **3.9** Food Habits of Stocked Fish
- **3.10** Reproduction of Stocked Fish
- **3.11** Hybridization of Stocked Fish
- **3.12** Impacts of Stocked Fish
- **3.13** Susceptibility to Predators
- **3.14** Stocking Economics
- **3.15** Health and Condition Factor of Stocked Fish
- **3.16** Effects of Handling and Acclimatization Time on Stocked Fish

Subject Index

1.0 General References
1.1 Stocking Policies and Management Objectives
Bonneau and Conley (1972)
Cooper (1948)
Guest (1985)
Heidinger (1976_b)
Holloway (1951)
Illinois Department of Natural Resources (1998)
Krumholz (1950)
Modde (1980)
Ontario Ministry of Natural Resources (1982)
O'Bara and Crunk (1998)
Redmond (1972)
Regier (1962)
Wenger (1972)
Wingate (1991)
Wisconsin Bureau of Fisheries Management and Habitat Protection (1999)

1.2 Reports of Stocking Projects
Anonymous (Undatede) (1896) (1897) (1901) (1902) (1903) (1914) (1915) (1930_a) (1930_b) (1932) (1931_a) (1953) (1961) (1964_a) (1964_b) (1965_a) (1965_b) (1967) (1973) (1979)
Bastedi (1903)
Bowen (1970)
Burley (1978)
Dawson (1960)
Erickson (1979)
Funk (1974)
Johnson et al. (1996)
Junor (1980)
Krieger (1983_a)
Leach et al. (1940)
Loska (1982_b)
MacFee (1957)
MacKay (1960)

Rideau Lakes Fishery Assessment Unit (Undated)
Robbins and MacCrimmon (1974)
Sharp (1897)
Smith (1991)
Toth (1983)
Toots (1970)
Westers (1963)
Wright and Sopuck (1979)

1.3 Bass Introductions
Alberta Environmental Protection (1994)
Anonymous (undated$_c$)
Armstrong (1985)
Azouz (1970)
Baldwin (1980_a)
Beach (1974)
Bowen (1970)
Catt (1949)
Crossman (undated)
Dalhberg and Scott (1971)
DeForest (1990)
Denmead (1950)
Dymond (1935)
Editor (1952)
Erdman (1969)
Ferris (1985)
Gliden (1931)
Graham (1971_a) (1973_a)
Griffiths (1939)
Grimaldi (1972)
Jubb (1973)
Kaffka (1978) (1998)
Kerr (1978)
Livingston (1989)
Lowman (1958)
MacCrimmon (1967)
McDowall (1968)
McIntyre (1983)
McKeown (undated)
McNeill (1995)
Miller and Alcorn (1943)
Monroe and Hicks (1985)
Mosindy (1998)
Ontario Ministry of Natural Resources (1989)
Reynolds (1973)
Sasaki (1961) (1971)
Shebley (1917)
Smith (1896)

1.3 Bass Introductions (cont'd)
- Somers (1986)
- Strickland (1985)
- Surber (1924)
- Thurston (1976) (1978)
- Tyson (1907)
- Vander Zanden and Rasmussen (2000)
- Walden (1953)
- Welcomme (1988)
- Wheeler and Maitland (1973)
- Wurtz-Arlet (1953)
- Wynne and Van Horn (1994)
- Zezula et al. (2000)

1.4 Largemouth Bass Stocking Literature Reviews
- Graham (1971$_a$)
- Heidinger (1976$_a$)
- Loska (1982$_b$)
- Newburg (1975)
- Wenger (1967) (1972)

2.0 Stocking Guidelines and Practices

2.1 General
- Anderson (1971)
- Anonymous (1963)
- Archambault et al. (1990)
- Barron (1966)
- Bonneau and Conley (1972)
- Borgeson (1987)
- Collins and Mitchell (1996)
- Dickson (undated)
- Erickson (1974)
- Gilliland and Boxrucker (1995)
- Kuehn (1982)
- Little (1959)
- MacCrimmon et al. (1974)
- Ministère du Loisir, de la Chasse et de la Pêche (1988)
- Mitzner and Hill (1976)
- Modde (1982)
- Mraz (1964)
- Muschett (1999)
- Ontario Ministry of Natural Resources (1989)
- Powell (1975)
- Prentice (1985)
- Smith et al. (1975)
- Smith and Reeves (1986)
- Swinge (1966)
- Swingle and Smith (1943)
- Weir (undated)
- Wenger (1968)
- Wurtz-Arlet (1953)

2.2 Stocking Frequency
- Buynak and Mitchell (1999)
- Ministère du Loisir, de la Chasse et de la Pêche (1988)
- Smith and Swingle (1943)
- Swingle (1945)

2.3 Time of Stocking
- Anonymous (undated$_b$) (1959)
- Buck and Hooe (1986)
- Burress (1951)
- Buynak and Mitchell (1999)
- Buynak et al. (1999)
- Collins and Mitchell (1996)
- Dickson (undated)
- Dillard and Novinger (1975)
- Dyche (1913)
- Fieldhouse (1971)
- Geihsler and Holder (1983)
- Hill (1999)
- Hunt and Annett (1994)
- Illinois Department of Natural Resources (1998)
- Johnson and MacCrimmon (1967)
- Krumholz (1952)
- Kuehn (1982)
- McIntyre (1982)
- Ministère du Loisir, de la Chasse et de la Pêche (1988)
- Neal et al. (2000)
- Paragamian (1977)
- Rawson and Rutton (1952)
- Smith et al (1975)
- Smith and Swingle (1943)
- Swingle and Smith (1943)

2.4 Stocking Rates
- Aldrich (1949)
- Ayers et al. (1967)
- Bennett (1952)
- Bonneau and Conley (1972)
- Borgeson (1987)
- Brown and Thoreson (1957)
- Burress and Weiss (1952)
- Deutsch et al. (1992)
- Dickson (undated)
- Dillard and Novinger (1975)
- Eipper and Regier (1962)
- Farquhar (2000)

2.4 Stocking Rates (cont'd)
Hall (1958)
Heidinger (1993)
Illinois Department of Natural Resources (1998)
Janney and Hartman (2000)
Ministère du Loisir, de la Chasse et de la Pêche (1988)
Mitzner (1974)
Mitzner and Hill (1976_b)
Mraz (1964)
Neal et al. (2000)
Ontario Ministry of Natural Resources (1989)
Paragamian et al. (1977)
Porak et al. (2000)
Powell (1975)
Shelley and Modde (1982)
Smith and Reeves (1986)
Smith et al. (1995)
Snow (1968)
Terre et al. (1993)
Tidwell, Coyle and Webster (1998)
Tidwell et al. (1998)
Weaver (1979)

2.5 Age/Size of Fish
Anonymous ($undated_b$) (1902) (1906) (1910) (1911) (1930_a) (1930_b) (1931_b) (1933) (1934) (1961) (1979) (1997) (1998)
Archambault et al. (1990)
Ball (1952)
Ball and Tait (1952)
Bonham (1946)
Bonneau and Conley (1972)
Borgeson (1987)
Brown (1951) (1952) (1961)
Buck and Hooe (1986)
Buynak (1985) (1986) (1995)
Buynak and Mitchell (1999)
Carlander (1952)
Carlander and Moorman (1957)
Childers and Bennett (1967)
Cichra et al. (1981)
Clark (1952)
Clugston (1964)
Collins and Mitchell (1996)
Cooper (1948)
Copeland and Noble (1994)
Crawford and Wicker (1987)
Crutchfield and Warren-Hicks (1985)
Dawson (1999)
Dickson (undated)
Dunham et al. (1992)
Dymond (1931)
Eipper and Regier (1962)
Emig (1966_a) (1966_b)
Farquhar (2000)
Filipek and Gibson (1986)
Fleener et al. (1974)
Forney (1972)
Fullerton et al. (2000)
Funk and Fleener (1973) (1974)
Gilliland and Whitaker (1989)
Goudreau (1998)
Hall (1958)
Harders (1974)
Harders and Davies (1973)
Hardesty (1994)
Heidinger (1976_b) (1993)
Hill (1979_b) (1999)
Hoey and Redmond (1972)
Hoxmeier and Wahl (2000)
Hunt and Annett (1994)
Illinois Department of Natural Resources (1998)
Janisch (1976)
Janney and Hartman (2000)
$Johnson_a$ (1996)
Johnson and MacCrimmon (1967)
Krumholz (1950) (1952)
Kuehn (1982)
Kurten (2000)
Lawson and Davies (1978)
Littkemann (1960)
Lockard (1971)
Martin (2000)
Marzolf (1954)
McIntyre (1973) (1982)
Mense (1980)
Ministère du Loisir, de la Chasse et de la Pêche (1988)
Mitchell et al. (1991)
Mitzner (1974) (1976)
Mraz (1964)
Oliver et al. (1979)
Ontario Ministry of Natural Resources (1989)
Paragamian (1977)
Pardue and Hester (1966)
Parmley et al. (1986)
Pescitelli and Ring (2000)

2.5 Age/Size of Fish (cont'd)
- Pitman and Gutreuter (1993)
- Porak et al. (2000)
- Powell (1975)
- Rawson and Rutton (1952)
- Redmond (1972)
- Reeves et al. (1995)
- Regier (1963)
- Rieger and Summerfelt (1976)
- Ryan et al. (1996)
- Satterfiled and Flickinger (1986)
- Shiels and Jackson (1993)
- Smith and Reeves (1986)
- Smith and Swingle (1943)
- Smith and Wilson (1981)
- Smith et al. (1975)
- Smitherman (1975)
- Snow (1975$_a$)
- Swingle (1951)
- Swingle and Smith (1940) (1943)
- Szalai and Dick (1998)
- Taub (1972)
- Terre et al. (1993)
- Thomas (2000)
- Tucker et al. (2000)
- Turman and Dennis (1998)
- Weaver (1979)
- Willis et al. (1987)
- Wisconsin Bureau of Fisheries Management and Habitat Protection (1999)
- Wright and Sopuck (1979)

2.6 Marking Techniques
- Arve (1961)
- Boucher (1993)
- Boxrucker (1982$_a$)
- Brooks (1980)
- Buynak and Mitchell (1999)
- Buynak et al. (1999)
- Coble (1971)
- Copeland and Noble (1994)
- Eipper and Forney (1965)
- Englehart (1977)
- Fieldhouse (1971)
- Filipek and Gibson (1986)
- Forney (1964) (1972)
- Freud and Hartmen (1999)
- Harrell and Dibble (1997)
- Hunt and Annett (1994)
- Jones et al. (2000)
- Jorgensen (undated)
- Krieger and Puttman (1986)
- Martin (2000)
- Neal et al. (2000)
- O'Bara et al. (1999)
- Pescitelli and Ring (2000)
- Porak et al. (2000)
- Rieger and Summerfelt (1976)
- Ricker (1949)
- Stroud (1955)
- Thomas (2000)
- Webster (1950)

2.7 Diseased Fish
- Anonymous (1961)
- Grant (1970)
- Johnson (1975)
- Johnson$_b$ (1996)
- Jorgenson (undated)
- Maitland and Price (1969)
- Odell and Senning (1937)
- Porak et al. (2000)
- Szalai and Dick (1998)
- Tucker et al. (2000)

2.8 Fish Community in Stocked Waters
- Anonymous (undated$_a$)
- Snyder and Girard (1991)
- Turner (1963)

2.9 Transport and Release Techniques
- Anonymous (1902) (1903) (1904) (1911) (1965$_b$) (1986)
- Carmichael (1984)
- Carmichael et al. (1983)
- Dawson (1999)
- Henshall (1917)
- Ontario Ministry of Natural Resources (1989)
- Rawson (1937$_a$)
- Seale (1910)
- Snow et al. (1978)
- Thurston (1978)
- Williamson and Carmichael (1987)

2.10 Stocking Site
- Bowman (1993)
- Forney (1972)
- Ministère du Loisir, de la Chasse et de la Pêche (1988)
- Thomas (2000)
- Weir (undated)
- Wurtz-Arlet (1953)

2.11 Genetic Strain

Addison and Spencer (1972)
Anderson et al. (1971)
Archambault et al. (1990)
Brown and Murphy (1994)
Bulak et al. (1995)
Chew (1975)
Childers (1975)
Cichra et al. (1981)
Clugston (1964)
Davies (1973)
Dunham et al. (1992)
Forshage and Fries (1995)
Forshage and Gregg (1988)
Fries et al. (2000)
Fullerton et al. (2000)
Gelwick et al. (1995)
Gilliland (1991) (1994)
Goodman (1991)
Grant (1970)
Harper (1984)
Hoover (1992)
Hoover et al. (1991)
Hoyt (1974)
Inman et al. (1977)
Isely et al. (1987)
Johnson (1975)
Johnson and Anderson (1974)
Kleinsasser et al. (1990)
Leitner and Bulak (2000)
Malloy et al. (2000)
Ministère du Loisir, de la Chasse et de la Pêche (1988)
Moyle and Holzhauser (1978)
Nieman and Clady (1978)
Philipp and Claussen (1988)
Philipp and Whitt (1989) (1991)
Philipp et al. (1981) (1984)
Rieger et al. (1978)
Smith (1976)
Smith and Wilson (1981)
Wight and Wigtil (1981)
Wynne and Van Horn (1994)
Zolcynski and Davies (1976)

2.12 Physical/Chemical Requirement of Stocked Waters

Aldrich (1949)
Anderson (1948)
Anderson et al. (1971)
Anonymous (undatedd) (1910) (1931$_b$)
Archambault et al. (1990)
Armstrong and Mackereth (2000)
Bowman (1993) (1994)
Brown et al. (2000)
Buynak (1985)
Buynak et al. (1991)
Eipper and Regier (1962)
Emig (1966$_a$)
Farquhar (2000)
Geihsler and Holder (1983)
Grimaldi (1972)
Hebda et al. (1990)
Henshall (1917)
Hill (1999)
Holloway (1951)
Hunt and Annett (1994)
Kerr (1978)
Kuehn (1982)
Leitner and Bulak (2000)
Moorman (1956)
Morgan (1958) (1960)
Mraz (1954)
Ontario Ministry of Natural Resources (1976) (1989)
Snucins and Shuter (1991)
Stone and Modde (1982)
Surber (1945)
Thomas (2000)
Tidwell et al. (1998)
Tucker et al. (2000)
Wurlz-Arlet (1953)
Zezula et al. (2000)

2.13 Stocking Farm Ponds

Aldrich (1949)
Anderson (1948)
Anonymous (undated$_a$)
Ayers et al. (1967)
Ball (1952)
Barney and Canfield (1922)
Bivings et al. (1981)
Bond (1958)
Bonhan (1946)
Brown (1951) (1952)
Brown and Thoreson (1951)
Brynildson and Truogg (1959)
Carlander (1952)
Carlander and Moorman (1957)
Carnes (1960)
Carter (1968)
Clark (1952)
Davies (1974)
Davison (1955)
Degani (1950)
Dillard and Hamilton (1969)

2.13 Stocking Farm Ponds (cont'd)

Dillard and Novinger (1975)
Dyche (1914)
Eipper and Regier (1962)
Fong (1979)
Gasaway (1968)
Graham (1969) (1970$_a$) (1970$_b$)
Harders (1974)
Hill (1979$_a$) (1979$_b$) (1999)
Holloway (1951)
Hooper (1970)
Kirk (1999)
Krumholz (1950) (1952)
Leitner and Bulak (2000)
Lewis and Heidinger (1973)
Lopinot (1993) (1999)
Meehean (1952)
Mitzner and Hill (1976$_a$)
Modde (1982)
Moorman (1956)
Morgan (1958)
Nagel and Clark (1938)
Rawson and Rutton (1952)
Regier (1960) (1963$_a$) (1963$_b$) (1963$_c$)
Saila (1952)
Smith (1976)
Smith and Wilson (1981)
Smith et al. (1955)
Surber (1949)
Swingle (1949$_a$) (1952) (1956)
Swingle (1970)
Swingle and Smith (1940) (1947)

2.14 Stocking Combinations and Ratios

Aldrich (1943) (1949)
Anderson (1948)
Anonymous (undated$_a$) (1931$_b$) (1968)
Ball (1952)
Ball and Tait (1952)
Barney and Canfield (1922)
Beck (1986)
Bennett (1948) (1951) (1952) (1954) (1972)
Bennett and Childers (1957) (1966)
Bennett et al. (1962) (1973)
Bonham (1946)
Bonneau and Conley (1972)
Borgeson (1987)
Brown (1951) (1952)
Brown and Thoreson (1951)
Brunson and Robinette (1986)
Brynildson and Truogg (1959)
Buck et al. (1974)
Burress (1949) (1951) (1953$_a$) (1953$_b$)
Burress and Weiss (1952)
Byrd and Moss (1955)
Carlander (1952)
Childers and Bennett (1967$_a$) (1967$_b$)
Christenson et al. (1982)
Clady (1980)
Clark (1952)
Collins and Mitchell (1996)
Crance and McBay (1966)
Cross (1971)
Davies (1974)
Davison (1955)
Dickson (Undated)
Dillard and Hamilton (1969)
Dillard and Novinger (1975)
Dunham (1949)
Dyche (1913) (1914)
Edwards (1977)
Eipper and Regier (1962)
Emig (1966$_a$)
Fong (1979)
Gasaway (1968)
Gilbraith (1987)
Graham (1970$_b$) (1971$_b$) (1972) (1973$_b$)
Guy (1990)
Hall (1958)
Hansen et al. (1960)
Harders (1974)
Harders and Davies (1973)
Harrell and Dible (1997)
Heidinger (1976$_b$) (1993)
Henderson (1970)
Hill (1967) (1979$_a$) (1979$_b$) (1999)
Hoey and Redmond (1972)
Holcomb (1967$_a$)
Holloway (1951)
Hooper (1970)
Janisch (1976)
Johnson and Graham (1978)
Johnson and MacCrimmon (1967)
Jorgensen (undated)
Kempinger and Morsell (1969)
Kempinger et al. (1982)
King (1942) (1960)
Kirk (1999)
Krumholz (1950) (1952)

2.14 Stocking combinations and ratios (cont'd)

Kuhn (1980)
Larimore (1957)
Lewis and Heidinger (1973)
Lopinot (1973)
Meehean (1952)
Mitzner and Hill (1976$_a$)
Modde et al. (1986)
Moorman (1956)
Mraz and Cooper (1957)
Muncy (1966)
Nail and Powell (1975)
Novinger (1980)
O'Bara et al. (1997)
Ontario Ministry of Natural Resources (1989)
Panek (1978)
Paragamian (1976$_a$)
Powell (1975)
Prather (1970)
Regier (1960) (1962) (1963$_b$) (1963$_c$)
Rickett (1976)
Rosebery (1950)
Saila (1952)
Shelley and Modde (1982)
Smith and Keller (2000)
Smith and Swingle (1942) (1943)
Smith et al. (1955) (1975)
Smitherman (1975)
Snow (1975$_b$)
Stone and Modde (1982)
Sumner (1968)
Surber (1949)
Swingle (1945) (1949$_a$) (1949$_b$) (1951) (1952) (1956)
Swingle (1970)
Swingle and Smith (1940) (1943)
Swingle et al. (1964)
Travis (1968)
Wenger (1967)

2.15 Bass Transfers

Anonymous (undated$_b$) (undated$_c$) (1896) (1901) (1902) (1904) (1930$_a$) (1930$_b$) (1931$_b$) (1934) (1953) (1959) (1964$_a$) (1973) (1986) (1999)
Baldwin (1950) (1951)
Boudreau (1987)
Burley (1978)
Carpenter et al. (1987)
Deyne and Tough (1995)
Dymond (1931)
Ellah (1969)
Gliden (1931)
Hardesty (1994)
Henderson and Foster (1966)
Henshall (1883)
Johnsona (1996)
Jorgensen (undated)
Loblaw and Cawthorn (1970)
Martin (1953)
McIntyre (1983) (1984)
Miller (1988)
Page (1880)
Rawson (1937$_a$)
Reynolds (1973)
Seale (1910)
Smiley (1882)
Weathers et al. (1994)
Welcomme (1988)
Wilmot (1877)
Wisconsin Bureau of Fisheries Management and Habitat Protection (1999)

3.0 Stocking Assessment

3.1 General

Ager (1978)
Aloo (1988)
Anderson (1948) (1966)
Anonymous (undated$_b$) (1902) (1904) (1906) (1910) (1911) (1912) (1933) (1934) (1944) (1997) (1998)
Azouz (1970)
Bain (1993)
Baldwin (1926) (1947$_b$) (1949$_b$)
Bishop (1971)
Blommer and Gustaveson (1997)
Bonham (1946)
Boudreau (1987)
Boxrucker (1986)
Brock (1960)
Buynak (1985)
Carnes (1960)
Catt (1949)
Cheatum et al. (1943)
Childers and Bennett (1967$_a$)
Clark (1952)
Crawford et al. (1995)

3.1 General Stocking Assessment (cont'd)

- Crutchfield and Warren-Hicks (1985)
- Dames et al. (1996)
- Degani and Hamilton (1969)
- Doan (1940)
- Duerre (1966)
- Ebert et al. (1985)
- Emig (1966_b)
- Fajen (1981)
- Ferris (1985)
- Forney (1964)
- Gregg and Rutledge (1990)
- Harrison (1930) (1953)
- Hart (1978)
- Henshall (1883)
- Holcomb (1967_b)
- MacFee (1957)
- Marshall and Johnson (1971)
- Mauck (1984)
- McIntyre (1982) (1984)
- Milewski (1990)
- Moen (1960)
- Morgan (1960)
- Mulford (1984)
- Noble (2000)
- Pasko (1959)
- Philipp (2000)
- Philipp and Claussen (1988)
- Philipp and Whitt (1989)
- Rach and Bills (1989)
- Rawson (1937_b)
- Rawson and Rutton (1952)
- Reeves et al. (1995)
- Riel (1967)
- Robinson (1961)
- Saila (1952)
- Smith (1971) (1991)
- Smith and Keller (2000)
- Snyder and Girard (1991)
- Stevenson (1973)
- Swingle (1949_a) (1966)
- Turner (1963)
- Virginia Commission of Game and Inland Fisheries (1957)
- Wallis (1950)
- Welcomme (1988)

3.2 Stocking Evaluation Projects

- Armstrong (1985)
- Baldwin (1951) (1980_b)
- Brooks (1980)
- Brown (1951)
- Brown et al. (2000)
- Burress (1951) (1953_a) (1953_b)
- Busak et al. (1987)
- Buynak (1986) (1995)
- Buynak et al. (1991)
- Crowell (1980_a) (1980_b)
- DeForest (1990)
- Degani (1950)
- Dillard (1971)
- Farquhar (2000)
- Fieldhouse (1971)
- Filipek and Gibson (1986)
- Fleener (1956) (1968)
- Fleener et al. (1974)
- Follis (1974)
- Funk and Fleener (1974)
- Geihsler and Holder (1983)
- Goudreau (1998)
- Graham (1972)
- Hall (1977)
- Hall et al. (1985)
- Hansen (1966)
- Hoxmeier and Wahl (2000)
- Inko-Tariah (1976)
- Inman et al. (1977)
- Kempinger et al. (1982)
- King (1942)
- Kleinsasser et al. (1990)
- Krieger (1983_b)
- Krieger and Puttman (1986)
- Kuhn (1980)
- Laarman (1979)
- Littkemann (1960)
- Maceina (1987)
- Maceina and Murphy (1987)
- Maceina et al. (1988)
- McLeod et al. (1975)
- Mellan (1987)
- Merner (1958)
- Miller (1988)
- Morgan (1958)
- Ney et al. (1991)
- Nieman and Clady (1978)
- Novinger (1980)
- O'Bara et al. (1997)
- Oliver et al. (1979)
- Palacher (1984)
- Paragamian (1977)
- Peeters (1978)
- Rawson (1943)
- Regier (1963_b) (1963_c)
- Rieger (1975)
- Rosebery (1950)
- Ryan et al. (1996)
- Sadowsky (1988)
- Shiels and Jackson (1993)
- Shrader (1993)

3.2 Stocking Evaluation Projects (cont'd)

Snow (1973)
Surber (1945) (1949)
Swingle (1949_b) (1951) (1952)
Swingle and Smith (1940)
Travis (1968)
Weaver (1979)
Webster (1950)
Weidel et al. (2000)

3.3 Post-Stocking Survival

Aldrich (1943)
Anderson et al. (1971)
Annett and Baily (1994)
Anonymous (1953)
Arve (1961)
Beck (1986)
Bliss (1971)
Boxrucker (1982_a) (1982_b)
Braun (1987)
Brown (1952)
Buckmeier and Betsill (2000)
Buynak and Mitchell (1999)
Buynak et al. (1999)
Coble (1971)
Doan (1940)
Dymond (1931)
Eipper and Regier (1962)
Forney (1972)
Freud and Hartman (1999)
Gilliland (1994)
Gilliland et al. (1989)
Hearn (1977) (1998)
Heidinger and Brooks (2000)
Hunt and Annett (1994)
Jackson et al. (2000)
Janney and Hartman (2000)
Johnson (1975)
Johnson and MacCrimmon (1967)
Johnson et al. (1993)
Little (1959)
Maceina and Murphy (1987)
Martin (2000)
Miranda and Hubbard (1994)
Mitzner (1974)
Mitzner and Hill (1976_a)
Mraz and Cooper (1957)
Neal et al. (2000)
Oliver et al. (1979)
Pardue and Hester (1966)
Philipp and Whitt (1991)
Pitman and Gutreuter (1993)
Porak et al. (1994) (2000)
Ricker (1949)
Rieger and Sumerfelt (1976)
Ryan et al. (1996)
Sadowsky (1988)
Smith and Swingle (1942)
Snow (1975_b)
Snucins and Shuter (1991)
Stone (1981)
Stone and Modde (1982)
Tezlaff (1989)
Tucker et al. (2000)
Weathers et al. (1994)
Wright and Wigtil (1981)
Wynne and Van Horn (1994)

3.4 Returns to the Fishery

Aldrich (1939)
Anderson et al. (1971)
Anonymous (undated_b) (1912) (1959) (1973) (1999)
Baldwin (1947_a) (1949_a) (1950)
Bennett (1951) (1954) (1972)
Bennett and Childers (1957)
Bennett et al. (1969) (1973)
Boucher (1993)
Brown (1961)
Buynak (1995)
Buynak and Mitchell (1999)
Buynak et al. (1999)
Byrd and Moss (1955)
Childers and Bennett (1967_a)
Christenson et al. (1982)
Crance and McBay (1966)
Crawford and Wicker (1987)
Davies (1974)
Ebert et al. (1985)
Fieldhouse (1971)
Fisher (1971)
Fleener and Funk (1958)
Fleener et al. (1974)
Forney (1972)
Forshage and Gregg (1988)
Funk and Fleener (1973) (1974)
Gilliland et al. (1989)
Grant (1970)
Hansen (1966)
Hickley et al. (1994)
Hoey and Redmond (1972)
Janney and Hartman (2000)
Kempinger and Morsell (1969)
King (1942) (1960)
Kleinsasser (1990)
Lawson and Davies (1978)
Loska (1982_a)
Lutterbie (1993)

3.4 Returns to the Fishery (cont'd)

MacFee (1957)
Martin (1953) (2000)
Meehean (1952)
Mitzner (1976)
Moffett (1943)
Moorman (1956)
Nail and Powell (1975)
Paragamian (1976_a) (1976_b)
Pescitelli and Ring (2000)
Porak et al. (1994)
Prentice (1985)
Prentice and Betsill (1997)
Redmond (197[illegible]
Rieger et al. (1978)
Rutledge and Gregg (1989)
Snow (1975_b)
Stocek and MacCrimmon (1965)
Straw et al. (1997)
Stroud (1955)
Swingle (1945) (1951) (1956)
Swingle and Smith (1943)
Turman and Dennis (1998)
Wallis (1950)
Weaver (1979)
Weck (1984)
Wright and Wigtil (1981)
Zolcynski and Davies (1976)

3.5 Meristic Variations of Hatchery-Reared Fish

Castro (1963)
Hoyt (1974)
Pelzman (1980)
Whitmore (1983)

3.6 Behaviour of Stocked Fish

Brunson and Robinette (1986)
Colgan et al. (1986)
Eipper and Forney (1965)
Jackson et al. (2000)
Porak et al. (2000)
Rawson (1937_b)
Rieger and Summerfelt (1976)

3.7 Growth of Stocked Fish

Addison and Spencer (1972)
Aldrich (1943) (1949)
Anderson et al. (1971)
Annett and Baily (1994)
Anonymous (1931_b) (1959) (1968)
Applegate and Kruckenberg (1978)
Baldwin (1947_a)
Ball and Tait (1952)
Beck (1986)
Bennett et al. (1989)
Bivings and Noble (1981)
Bonham (1946)
Bottroff and Lembeck (1978)
Boxrucker (1982_b)
Buck and Hooe (1986)
Burress (1949)
Clugston (1964)
Coble (1971)
Crowell (1980_b)
Doan (1940)
Eipper and Regier (1962)
Fieldhouse (1971)
Finnell (1956)
Forshage and Fries (1995)
Goudreau (1998)
Graham (1971_b) (1972)
Grant (1970)
Henderson and Foster (1956)
Hoey and Redmond (1972)
Inman et al. (1977)
Jackson et al. (2000)
Janney and Hartman (2000)
Janisch (1976)
Johnsona (1996)
Johnsonb (1996)
Johnson (1975) (1997)
Johnson and Graham (1978)
Johnson and MacCrimmon (1967)
Kauffman (1977)
Kleinsasser et al. (1990)
Krieger and Puttman (1986)
Krumholz (1952)
Kurten (2000)
Larimore (1954)
Leitner and Bulak (2000)
McNeill (1995)
Mitzner and Hill (1976_b)
Modde and Stone (1980)
Muncy (1966)
Neal et al. (2000)
Pardue and Hester (1966)
Philipp and Whitt (1991)
Porak et al. (2000)
Rawson (1937_a)
Ricker (1949)
Rickett (1976)
Rieger and Summerfelt (1976)
Satterfield and Flickinger (1986)
Smith (1976)
Smith and Keller (2000)
Smith and Wilson (1987)

3.7 Growth of Stocked Fish (cont'd)

Smitherman (1975)
Snow (1968)
Stone (1987)
Stone and Modde (1982)
Tidwell, Coyle and Webster (1998)
Tidwell et al. (1998)
Turman and Dennis (1998)
Week (1984)
Wright and Wigtil (1981)
Wynne and Van Horn (1994)
Zezula et al. (2000)
Zolcynski and Davies (1976)

3.8 Movements of Stocked Fish

Anonymous (1997)
Brown (1961)
Buckmeier and Betsill (2000)
Copeland and Noble (1994)
Forney (1964)
Freud and Hartmen (1999)
Gilliland et al. (1989)
Hughes and Douglas (1966)
Jackson et al. (2000)
Johnson et al. (1993)
Jones et al. (2000)
Larimore (1954)
Pardew (1992)

3.9 Food Habits of Stocked Fish

Aldrich (1943)
Anderson et al. (1971)
Anonymous (undated$_a$) (1931$_b$)
Applegate and Kruckenberg (1978)
Baldwin (1926)
Ball (1952)
Bennett (1952)
Bennett and Childers (1957) (1966)
Bennett et al. (1989)
Brown (1951)
Brunson and Robinette (1986)
Christie et al. (1972)
Coble (1971)
Colgan et al. (1986)
Cross (1971)
Dadzie and Aloo (1990)
Dyche (1913)
Fieldhouse (1971)
Forney (1972)
Fullerton et al. (2000)
Gilliland et al. (1989)
Hearn (1977) (1998)
Heidinger and Brooks (2000)
Henderson and Foster (1956)
Henshall (1917)
Hickley et al. (1994)
Janisch (1976)
Jenkins and Morais (1976)
Johnson and Graham (1978)
Johnson and Hale (1977)
Kurten (2000)
Mense (1980)
Moyle and Holzhauser (1978)
Nail and Powell (1975)
Parmley et al. (1986)
Porak et al. (2000)
Rach and Bills (1989)
Rogers (1968)
Smith and Keller (2000)
Snow (1968) (1975$_a$) (1975$_b$)
Somers (1986)
Taub (1972)
Tetzlaff (1989)
Tidwell, Coyle and Webster (1998)
Tucker et al. (2000)
Weidel et al. (2000)
Zezula et al. (2000)

3.10 Reproduction of Stocked Fish

Anonymous (undated$_a$) (1997)
Baldwin (1926) (1947$_b$)
Beck (1986)
Bennett (1954)
Bennett and Childers (1957)
Bonham (1946)
Brown (1939)
Buynak et al. (1991)
Childers and Bennett (1967$_a$)
Dadzie and Aloo (1990)
DeForest (1990)
Gilliland et al. (1989)
Henderson and Foster (1956)
Hill (1979$_a$)
Hoover (1992)
Isely et al. (1987)
Johnson, J. E. (1996)
Johnson and Graham (1978)
Johnson and Hale (1977)
Johnson and MacCrimmon (1967)
Livingston (1989)
Mayes et al. (1993)
Moffett (1943)
Moorman (1956)
Mraz (1954)
Ney et al. (1991)
Philipp et al. (1984)
Prather (1970)

3.10 Reproduction of Stocked Fish (cont'd)

Rawson (1937$_a$)
Rickett (1976)
Sadowsky (1988)
Shiels and Jackson (1993)
Smitherman (1975)
Stocek and MacCrimmon (1965)
Straw et al. (1997)
Swingle (1949$_b$)
Terre et al. (1993)
Thomas (2000)

3.11 Hybridization of Stocked Fish

Beaty and Childers (1980)
Bottroff (1967)
Bottroff and Lembeck (1978)
Buck and Hooe (1986)
Bulak et al. (1995)
Dunham et al. (1992)
Edwards (1979)
Farquhar (2000)
Fries et al. (2000)
Gelwick et al. (1995)
Gilliland and Whitaker (1989)
Goodman (1991)
Isely et al. (1987)
Johnsona (1996) (1997)
Kulzer et al. (1985)
Maceina (1987)
Maceina and Murphy (1987)
Maceina et al. (1988)
Malloy et al. (2000)
Mitchell et al. (1991)
Morizot et al. (1988)
Morizot et al. (1991)
Nogren et al. (1988)
Pelzman (1980)
Philipp (1991) (2000)
Philipp et al. (1981)
Pierce and Van Der Avyle (1997)
Terre et al. (1993)
Whitmore (1983)
Whitmore and Butler (1982)
Williams et al. (1996)
Wingate and McInterny (1997)

3.12 Impacts of Stocked Fish

Armstrong and Mackereth (2000)
Bennett et al. (1989)
Brunson and Robinette (1986)
Buckmeier and Betsill (2000)
Carpenter et al. (1987)
Casselman and Brown (2000)
Catt (1949)
Christie et al. (1972)
Dawson (1999)
Deyne and Tough (1995)
Dymond (1935)
Emig (1966$_b$)
Erdman (1969)
Findlay et al. (2000)
Fruetel (1995)
Goodman (1991)
Griffiths (1939)
Henshall (1883) (1917)
Jenkins and Morais (1976)
Johnson and Hale (1977)
Kerr and Grant (2000$_a$) (2000$_b$)
Kuehn (1982)
Lawson and Davies (1978)
Livingston (1989)
McIntyre (1973)
Modde et al. (1986)
Morizot et al. (1988)
Moyle and Holzhauser (1978)
Mraz (1954)
Odell and Senning (1937)
Page (1880)
Panek (1978)
Prentice (1985)
Rivero (1936)
Shelley and Modde (1982)
Skelton (1993)
Somers (1986)
Strickland (1985)
Vander Zanden and Rasmussen (2000)
Welcomme (1988)
Whittier and Kincaid (1999)
Wurtz-Arlet (1953)
Zezula et al. (2000)

3.13 Susceptibility to Predation

Baldwin (1947$_b$) (1980$_a$)
Miranda and Hubbard (1994)
Porak et al. (2000)

3.14 Stocking Economics

Bennett et al. (1973)
Buynak and Mitchell (1999)
Buynak et al. (1999)
Ellah (1969)
Lockard (1971)
Marzolf (1954)
Regier (1963$_a$)
Stroud (1955)
Swingle (1951)

3.15 Health and Condition Factor of Stocked Fish

Bennett et al. (1973)
Brooks (1980)
Buck and Hooe (1986)
Burnley (1994)
Carmichael et al. (1983)
Clark (1952)
Clugston (1964)
Emig (1966_b)
Johnsonb (1996) (1997)
Kleinsasser et al. (1990)
Mitzner (1974)
Moffett (1943)
Muncy (1966)
Regier (1963_b)
Smith and Wilson (1981)
Wynne and Van Horn (1994)

3.16 Effects of Handling and Acclimatization Time on Stocked Fish

Carmichael (1984)
Carmichael et al. (1983)
Englehart (1977)
Harrison (1930) (1953)
Johnson (1975)
Mayes et al. (1993)
Porak et al. (1994)
Shebley (1917)
Smith and Swingle (1943)
Williamson and Carmichael (1987)

APPENDIX 1. Largemouth bass stocking and transfers in Ontario waters, 1930-1999.

				Life Stage Stocked				
Year[1]	Eyed Eggs	Fry	Fingerlings	Yearlings	Subadults*	Adults*	Unknown	Total
1930	0	0	0	0	0	0	0	0
1931	0	35,000	18,310	0	0	0	0	53,310
1932	0	112,000	4,788	0	0	24[2]	0	116,812
1933	0	0	856	0	0	0	0	856
1934	0	35,250	4,250	0	0	197	0	39,697
1935	0	130,000	2,153	0	0	27	0	132,180
1936	0	45,000	7,260	0	0	138	0	52,398
1937	0	135,000	4,120	0	0	92	0	139,212
1938	0	57,500	8,035	0	0	26	0	65,561
1939	0	0	1,890	0	0	497	0	2,387
1940	0	230,000	5,500	0	0	152	0	235,652
1941	0	110,000	17,700	0	0	109	0	127,809
1942	0	185,000	19,100	0	0	290[2]	0	204,390
1943	0	507,500	38,500	0	0	290[2]	0	546,290
1944	0	130,000	14,600	0	0	51[2]	0	144,651
1945	0	0	5,000	0	0	0	0	5,000
1946	0	20,000	9,500	1,417	0	527[2]	0	31,444
1947	0	305,000	35,400	20,000	0	876[2]	0	361,276
1948	0	410,000	32,109	0	0	789[2]	23	442,921
1949	0	691,250	25,200	10,074	0	249[2]	0	726,773
1950	0	600,000	97,360	0	0	832[2]	0	698,192
1951	0	1,034,000	144,750	5,300	0	601	5,000	1,189,651
1952	0	544,000	167,750	1,750	0	962	500	714,692
1953	0	330,000	360,350	15,330	0	1,419	0	707,099
1954	1000	720,000	426,150	10,000	0	119	0	1,157,269
1955	0	290,500	343,300	0	0	3,522[2]	0	637,322
1956	0	360,000	180,015	0	0	1,495[2]	0	541,510
1957	0	190,000	128,830	0	0	2,922[2]	0	321,752
1958	0	46,000	72,600	2,500	0	1,851[2]	0	122,951
1959	0	45,000	46,500	0	0	144[2]	0	91,644
1960	0	230,550	29,500	0	0	20[2]	0	260,070
1961	0	0	26,050	148	0	1,442[2]	0	27,640
1962	0	55,000	112,120	0	0	746[2]	0	167,866
1963	0	45,000	92,550	1,200	0	35[2]	0	138,785
1964	0	112,000	92,750	0	0	0	0	204,750
1965	0	105,000	107,500	0	0	0	11,000	223,500
1966	0	83,000	147,000	2,000	0	0	13,500	245,500
1967	0	67,500	75,000	9,000	0	260	0	151,760
1968	0	60,000	49,900	4,199	0	1523[2]	0	115,622
1969	0	11,000	56,390	162	0	961[2]	3,000	71,513
1970	0	101,000	46,200	0	0	492[2]	0	147,692
1971	0	61,000	74,400	0	0	18[2]	0	135,418
1972	0	67,000	83,000	1,000	0	0	0	151,000
1973	0	47,700	59,200	0	0	0	0	106,900
1974	21,000	96,500	0	0	210	15,000	0	132,710
1975	110,000	47,000	0	0	0	10,000	0	167,000
1976	0	129,000	10,000	0	362	0	0	139,362
1977	36,000	80,000	0	0	701	0	0	116,701
1978	0	82,000	0	0	1,040	0	28,960	112,000
1979	0	0	0	0	407	0	0	407
1980	0	0	0	0	0	0	0	0
1981	0	0	0	0	454	0	0	454

Year	Eyed Eggs	Fry	Fingerlings	Yearlings	Subadults	Adults	Unknown	Total
1982	0	0	0	0	201	0	0	201
1983	0	0	0	0	105	0	0	105
1984	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0
1986	0	0	0	0	67	0	0	67
1987	0	0	0	0	755	0	0	755
1988	0	0	0	268	555	0	0	823
1989	0	0	0	0	50	0	0	50
1990	0	0	0	100	40	0	0	140
1991	0	0	0	50	12	0	124	186
1992	0	0	0	185	0	30	360	575
1993	0	0	0	0	72	0	115	187
1994	0	0	0	0	0	0	28	28
1995	0	0	0	0	0	0	285	285
1996	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0

*It is assumed that the majority of the subadult and adult stocking were done with transfers from one waterbody to the next.

[1] The information presented for is only of confirmed, accurate numbers of fish stocked.

[2] Combination of yearlings and adults.

APPENDIX 2. Smallmouth bass stocking and transfers in Ontario waters, 1884-1999.

	Life Stage Stocked							
Year[1]	Eyed Eggs	Fry	Fingerlings	Yearlings	Subadults*	Adults*	Unknown	Total
1884	0	50,000	0	0	0	0	0	50,000
1885	0	0	0	0	0	0	0	0
1886			Information	Not Available				
1887	0	0	0	0	0	0	0	0
1888	0	1,000,000	0	0	0	0	0	1,000,000
1889	0	80,000	0	0	0	0	0	80,000
1890	0	0	0	0	0	0	0	0
1891	0	0	0	0	0	0	0	0
1892			Information	Not Available				
1893	0	0	0	0	0	0	0	0
1894	0	0	0	0	0	0	0	0
1895	0	0	0	0	0	0	0	0
1896	0	0	0	0	0	0	0	0
1897	0	0	0	0	0	0	0	0
1898			Information	Not Available				
1899	0	0	0	0	0	0	0	0
1900	0	0	0	0	0	0	0	0
1901	0	0	0	0	0	0	9,841	9,841
1902	0	0	0	0	0	0	2,004	2,004
1903	0	0	0	0	0	0	7,927	7,927
1904	0	0	7,600	0	0	0	5,355	12,955
1905	0	0	0	0	0	0	3,100	3,100
1906	0	0	0	0	0	0	5,435	5,435
1907			Information	Not Available				
1908	0	0	725	0	0	0	1,020	1,745
1909	0	0	14,550	0	0	0	0	14,550
1910	0	0	37,625	0	0	75	0	37,700
1911	0	0	90,200	0	0	0	0	90,200
1912	0	0	80,000	0	0	300	0	80,300
1913	0	0	90,400	0	0	265	0	90,665
1914	0	205,500	274,500	0	0	330	0	480,330
1915	0	50,000	780,000	0	0	425	0	830,425
1916	0	0	900,000	0	0	450	0	900,450
1917	0	0	735,000	0	0	428	0	735,428
1918	0	0	0	0	0	131	0	131
1919	0	0	200,500	0	0	548	0	201,048
1920	0	0	427,000	0	0	460	0	427,460
1921	0	0	773,500[2]	0	0	742	0	774,242
1922	0	0	613,500[2]	0	0	937	0	614,437
1923	0	0	59,000[2]	0	0	997	0	59,997
1924	0	0	338,000[2]	0	0	1,111	0	339,111
1925	0	0	9,000	0	0	611	0	9,611
1926	0	0	12,500[2]	0	0	1,569	0	14,069
1927	0	0	5,425	0	0	0	0	5,425
1928	0	0	60,433[2]	0	0	90	0	60,523
1929	0	60,000	15,080	1,245	0	145	0	76,470
1930	0	386,091	8,414	0	1,115	1,007	0	396,627
1931	0	367,500	111,625	0	10,094	0	0	489,219
1932	0	588,000	29,400	0	0	7,948[3]	0	625,348
1933	0	545,000	25,750	0	0	3,471[3]	0	574,221
1934	0	365,500	35,750	0	0	420	0	401,670
1935	0	691,000	152,565	866	0	2,569	0	847,000

Year	Eyed Eggs	Fry	Fingerlings	Yearlings	Subadults	Adults	Unknown	Total
1936	0	775,000	69,380	0	0	2,132	0	846,512
1937	0	1,275,000	141,900	0	0	5,893[3]	0	1,422,793
1938	0	804,000	169,800	0	0	7,138[3]	0	980,938
1939	0	1,386,000	226,325	0	0	7,739[3]	0	1,620,064
1940	0	2,512,500	449,154	0	0	1,671[3]	0	2,963,325
1941	0	1,911,590	691,925	0	0	2,254[3]	0	2,605,769
1942	0	1,535,500	718,259	0	0	2,355[3]	0	2,256,114
1943	0	1,512,000	392,700	0	0	1,369[3]	0	1,906,069
1944	0	2,030,000	664,400	0	0	2,834[3]	0	2,697,234
1945	0	448,000	348,368	0	0	5,322[3]	0	801,690
1946	10,000	476,375	317,080	455	0	4,418[3]	2,257	810,585
1947	0	1,457,000	579,925	0	0	5,099[3]	0	2,042,024
1948	0	1,402,500	554,900	0	0	3,459[3]	0	1,960,859
1949	0	2,149,500	1,957,185	4,203	0	15,466[3]	29,600	4,155,954
1950	0	1,505,500	346,200	0	0	9,151	0	1,860,851
1951	200,000	986,600	424,219	14,052	0	13,910	0	1,638,781
1952	0	357,500	384,965	0	0	14,688	0	757,153
1953	0	720,000	623,220	0	0	17,763	0	1,360,983
1954	0	820,000	452,200	0	0	13,654	0	1,285,854
1955	0	209,000	529,135	0	0	25,080[3]	0	763,215
1956	0	803,000	368,500	2,817	0	19,336[3]	2,198	1,195,851
1957	0	467,500	131,700	0	0	665[3]	0	599,865
1958	0	130,000	132,750	0	0	4,468[3]	0	267,218
1959	0	89,000	227,200	0	0	499[3]	0	316,699
1960	0	156,000	177,600	0	0	510[3]	0	334,110
1961	0	230,000	270,200	0	0	619[3]	0	500,819
1962	0	147,000	177,300	0	0	291[3]	0	324,591
1963	0	134,000	287,700	0	0	316	0	422,016
1964	0	52,000	239,450	0	0	290	0	291,740
1965	0	58,000	231,700	0	0	165	0	289,865
1966	0	36,200	215,500	0	0	160	0	251,860
1967	0	98,000	211,950	0	0	178	0	310,128
1968	0	38,200	91,000	0	0	181	0	129,381
1969	0	86,000	113,550	0	0	110	0	199,660
1970	0	99,000	28,500	0	0	0	0	127,500
1971	0	126,990	8,500	0	0	0	0	135,490
1972	0	0	116,600	0	0	0	0	116,600
1973	0	93,000	147,000	0	0	0	0	240,000
1974	0	0	0	0	0	0	173,000	173,000
1975	0	0	0	0	0	0	106,000	106,000
1976	0	0	0	0	0	0	106,000	106,000
1977	59,000	0	0	0	0	0	208,000	267,000
1978	0	0	0	0	0	0	185,000	185,000
1979	0	0	0	0	0	0	79,000	79,000
1980	0	0	0	0	0	0	65,000	65,000
1981	0	0	0	0	0	0	160,008	160,008
1982	0	0	0	0	0	0	0	0
1983	0	0	0	0	250	0	0	250
1984	0	0	0	0	0	0	135,926	135,926
1985	0	60,000	4,700	0	506	0	0	65,206
1986	0	0	24,000	0	1,786	0	0	25,786
1987	0	10,700	4,800	0	2,324	0	0	17,824
1988	0	9,300	0	0	888	0	0	10,188
1989	0	1,500	0	0	1,230	0	0	2,730

Year	Eyed Eggs	Fry	Fingerlings	Yearlings	Subadults	Adults	Unknown	Total
1990	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0
1992	0	0	104	0	0	73	0	111
1993	0	476	0	0	0	81	0	557
1994	0	0	0	0	0	20	0	20
1995	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	528	0	528
1997	0	0	0	0	0	20	350	370
1998	0	0	0	0	0	0	600	600
1999	0	0	0	0	240	750	0	990

*It is assumed that the majority of the subadult and adult stocking were done with transfers from one waterbody to the next.

[1] The information presented is only of confirmed, accurate numbers of fish stocked.

[2] Combination of fry and fingerlings.

[3] Combination of yearlings and adults.

APPENDIX 3. Records of selected bass transfers and introductions in Ontario waters based on a 2000 survey of OMNR field staff. The term "initial" indicates the first year of transfers to that particular waterbody, while "final" indicates the last.

Year(s)	Recipient Waterbody (Township(s))	Donor Waterbody (Township(s))	Life Stage	Species Stocked	Number Stocked
Unknown	Alston Lake (13 H)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
Unknown	Elk Lake (James & Smyth)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
Unknown	Holmes Lake (Holmes & Flavelle)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
Unknown	Mountain Lake (Barber)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1903	White Lake (Bagot, McNab & Darling)	Unknown (Unknown)	Adults	Smallmouth bass	100
1904	White Lake (Bagot, McNab & Darling)	Unknown (Unknown)	Adults	Smallmouth bass	100
1917-1944	Rainy Lake (Rainy River district)	Unknown (Unknown)	Fingerlings	Smallmouth bass	8,498
1923	Kenogami Lake (Grenfell & Eby)	Unknown (Unknown)	Unknown	Smallmouth bass	5,000
1926	Missinaibi Lake (Missinaibi, Barclay, Baltic & Brackin)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1930-1932	Patterson Lake (Unknown)	Unknown (Unknown)	Adults	Smallmouth bass	146
1930	Pike Lake (North Crosby & North Burgess)	Unknown (Unknown)	Adults	Smallmouth bass	50
1931	Pike Lake (North Crosby & North Burgess)	Unknown (Unknown)	Adults	Smallmouth bass	100
1932	White Lake (Bagot, McNab & Darling)	Unknown (Unknown)	Adults	Smallmouth bass	100
1932	Pike Lake (North Crosby & North Burgess)	Unknown (Unknown)	Adults	Largemouth bass	100

Year	Recipient Waterbody (Township(s))	Donor Waterbody (Township(s))	Life Stage	Species Stocked	Number Stocked
1937	Least Lake (Nimitz)	Unknown (Unknown)	Yearlings	Smallmouth bass	5,000
1937	McGowan Lake (Lanark)	Unknown (Unknown)	Fingerlings	Smallmouth bass	500
1937/1938	Beartrap Lake (Terrace Bay district)	Manitou (Manitoulin Island)	Unknown	Smallmouth bass	Unknown
1938	Windermere Lake (35, 36 & 37)	Unknown (Unknown)	Adults	Smallmouth bass	Unknown
1940s (approx.)	Cordingley Lake (Alpha)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1940	Biscotasi Lake (Biscotasi)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1940	Otisse Lake (Powell & Baden)	Unknown (Unknown)	Fingerlings	Smallmouth bass	500
1942	Rainy Lake (Rainy district)	Unknown (Unknown)	Fingerlings	Largemouth bass	2,349
1950	Kernick (Pike) Lake (Armour)	Skeleton Lake (Armour)	Unknown	Smallmouth bass	120
1950	Sisters Lakes (Terrace Bay district)	Cook Lake (Township N. 84)	Unknown	Smallmouth bass	250
Mid 1950s	Bass Lake (Rickard)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
pre-1951	Raven Lake (McFadden)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1951	Hangingstone Lake (Leith & Milner)	Otisse Lake (Powell)	Adults	Smallmouth bass	100
1951	Hangingstone Lake (Leith & Milner)	Otisse Lake (Powell)	Adults	Smallmouth bass	126
1951	Hough Lake (Marquis & Savard)	Otisse Lake (Powell)	Adults	Smallmouth bass	100

Year	Recipient Waterbody (Township(s))	Donor Waterbody (Township(s))	Life Stage	Species Stocked	Number stocked
1951	Hough Lake (Marquis & Savard)	Otisse Lake (Powell)	Adults	Smallmouth bass	400
1951	Lett Lake (Milner)	Otisse Lake (Powell)	Adults	Smallmouth bass	100
1951	Little Silver Lake (South Sherbrooke)	Unknown (Unknown)	Unknown	Largemouth bass	Unknown
1951	Long Lake (Sharpe & Robillard)	Unknown (Unknown)	Adults	Smallmouth bass	40
1951	Middleton Lake (Flavelle)	Otisse Lake (Powell)	Adults	Smallmouth bass	250
1951	Middleton Lake (Flavelle)	Otisse Lake (Powell)	Adults	Smallmouth bass	200
1951	Montreal River (Cairo)	Otisse Lake (Powell)	Adults	Smallmouth bass	150
1951	Pike Lake (Milner)	Otisse Lake (Powell)	Adults	Smallmouth bass	24
1951	Pike Lake (Milner)	Unknown (Unknown)	Adults	Smallmouth bass	100
1951	Wendigo Lake (Bayly)	Otisse Lake (Powell)	Adults	Smallmouth bass	400
1951	Wendigo Lake (Bayly)	Unknown (Unknown)	Adults	Smallmouth bass	100
1953 (final)	Butler Lake (Black)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1953	Long Lake (Sharpe & Robillard)	Unknown (Unknown)	Adults	Smallmouth bass	35
1953	Long Lake (Macklem)	Unknown (Unknown)	Fingerlings	Unknown	800
1954	Amikougami Lake (Bernhardt)	Unknown (Unknown)	Adults	Smallmouth bass	83
1954	Firth Lake (Van Hise)	Unknown (Unknown)	Adults	Smallmouth bass	86

Year	Recipient Waterbody (Township(s))	Donor Waterbody (Township(s))	Life Stage	Species Stocked	Number Stocked
1954	Long Lake (Sharpe & Robillard)	Unknown (Unknown)	Adults	Smallmouth bass	76
1954-1955	Pooles Lake (Lamarche)	Alexo Lake (Dundonald)	Adults	Smallmouth bass	30
1955	Long Lake (Sharpe & Robillard)	Unknown (Unknown)	Adults	Smallmouth bass	35
1955 (final)	Long Point Lake (Chown)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1955	MacDonald Lake (Deloro)	Unknown (Unknown)	Adults	Smallmouth bass	50
1955 (final)	Mistinikon Lake (Powell & Baden)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1955	Wendigo Lake (Bayly)	Unknown (Unknown)	Adults	Smallmouth bass	100
pre-1957	Malloch Lake (Black)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1957	Campbell Lake (Clifford)	Unknown (Unknown)	Adults	Smallmouth bass	51
1957	White Lake (Bagot, McNab & Darling)	Unknown (Unknown)	Unknown	Largemouth bass	Unknown
1958	Campbell Lake (Clifford)	Unknown (Unknown)	Adults	Smallmouth bass	31
pre-1959	Bear Lake (McVittie & McGarry)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
pre-1959	Beaver Lake (McVittie & McGarry)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
pre-1959	Tournene Lake (McVittie)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1959	Niobe Lake (Rainy River district)	Unknown (Unknown)	Adults	Smallmouth bass	34

Year	Recipient Waterbody (Township(s))	Donor Waterbody (Township(s))	Life Stage	Species Stocked	Number Stocked
pre-1960	Lost Lake (Haultain)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1960	Firth Lake (Van Hise)	Unknown (Unknown)	Adults	Smallmouth bass	86
pre-1961	Barber Lake (McGarry)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
pre-1962	Gowganda Lake (Milner)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
pre-1964	Sisseney Lake (Yarrow & More)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1964	Ellis Creek (Waterloo)	Shakespeare Pond North Easthope	Unknown	Largemouth bass	275
1964 (final)	Shaver Lake (McGarry)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1965	Snyder's Pond (Puslinch)	Shakespeare (North Easthope)	Unknown	Largemouth bass	141
1966	Valens Reservoir (West Flamborough)	Shakespeare Pond (North Easthope)	Unknown	Largemouth bass	Unknown
pre-1967	Beaverhouse Lake (McVittie & Katrine)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
pre-1967	Hubert Lake (Farr)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
pre-1967	Misema Lake (Katrine & Arnold)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1967	Mountsberg Reservoir (East Flamborough)	Shakespeare Pond (North Easthope)	Unknown	Largemouth bass	1,000
1967 (final)	Talbock Lake (Playfair)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1967	Valens Reservoir (West Flamborough)	Shakespeare Pond (North Easthope)	Unknown	Largemouth bass	7,500

Year	Recipient Waterbody (Township(s))	Donor Waterbody (Township(s))	Life Stage	Species Stocked	Number Stocked
1968	Buell's Creek Reservoir (Unknown)	Unknown (Unknown)	Fry	Largemouth bass	4,000
1968	Otisse Lake (Powell & Baden)	Unknown (Unknown)	Fingerlings	Smallmouth bass	500
pre-1969	Mendelssohn Lake (Speight)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1969	Crooks Hollow Pond (West Flamborough)	Valens Pond (West Flamborough)	Unknown	Smallmouth bass	100
1969	Otty Lake (Lanark)	Little Silver Lake (Lanark)	Adults	Smallmouth bass Largemouth bass	19 150
1969	Schneider Creek (Waterloo)	Shakespeare Pond (North Easthope)	Unknown	Largemouth bass	150
1969	Tay River (Lanark)	Loon Lake (Lanark)	Adults	Largemouth bass	17
1969	Unnamed Six Nations Reservation Pond (Tuscarora)	Shakespeare Pond (North Easthope)	Unknown	Largemouth bass	150
pre-1970	Howard Lake (Arnold)	Unknown (Unknown)	Unknown	Smallmouth bass	234
pre-1972	Sesekinika Lake (Grenfell)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
pre-1972	Skeletonpup Lake (Bayly)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1972	Long Lake (Sharpe & Robillard)	Unknown (Unknown)	Fry	Smallmouth bass	Unknown
pre-1973	Bloom Lake (Haultain & Morel)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
pre-1973	Serpentine Lake (Van Hise)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1973	Hazel Lake (Bisley)	Middleton (Flavelle)	Fry	Smallmouth bass	20,000

Year	Recipient Waterbody (Township(s))	Donor Waterbody (Township(s))	Life Stage	Species Stocked	Number Stocked
pre-1976	Gull Lake (Lebel)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
pre-1976	Round Lake (Otto & Boston)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1976	Friday Lake (Best and Gillies)	Sandfield Hatchery	Fry	Smallmouth bass	20,000
1976	Horn Lake (Monteith)	Nogies Creek (Harvey)	Adults	Largemouth bass	143
1976	Mead Lake (Monteith)	Martin Lake (Christie)	Adults	Largemouth bass	219
1977	Friday Lake (Best and Gillies)	Sandfield Hatchery	Fry	Smallmouth bass	15,000
pre-1978	Skeleton Lake (Mulligan & Bayly)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1978	Axe Lake (McMurrich)	Neville Lake (McDougall)	Adults	Largemouth bass	130
1978	Axe Lake (McMurrich)	Simmes Lake (Carling)	Adults	Largemouth bass	76
1978	Dinner Lake (Shawanaga)	Cole Lake (Carling)	Adults	Largemouth bass	31
1978	Dinner Lake (Shawanaga)	Martin Lake (Christie)	Adults	Largemouth bass	21
1978	Friday Lake (Best and Gillies)	Sandfield Hatchery	Fry	Smallmouth bass	15,000
1978	Imrie Lake (Carling)	Martin Lake (Christie)	Adults	Largemouth bass	83
1978	Manitouwaba Lake (Monteith)	Cole Lake (Carling)	Adults	Largemouth bass	36
1978	Manitouwaba Lake (Monteith)	Pender Lake (Foley)	Adults	Largemouth bass	81

Year	Recipient Waterbody (Township(s))	Donor Waterbody (Township(s))	Life Stage	Species Stocked	Number Stocked
1978	Mowat Lake (Mowat)	Cole Lake (Carling)	Adults	Largemouth bass	43
1978	Mowat Lake (Mowat)	Martin Lake (Christie)	Adults	Largemouth bass	54
1978	Wiwassasegen Lake (Shawanaga)	Cole Lake (Carling)	Adults	Largemouth bass	16
1978	Wiwassasegen Lake (Shawanaga)	Martin Lake (Christie)	Adults	Largemouth bass	93
pre-1979	Penassi Lake (Van Hise & Rankin)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1979	Cranberry Lake (Harrison)	Yarrow Lake (McDougall)	Adults	Largemouth bass	91
1979	Cranberry Lake (Harrison)	Nevelle Lake (McDougall)	Adults	Largemouth bass	34
1979	Cranberry Lake (Harrison)	Brennan Lake (Foley)	Adults	Largemouth bass	52
1979	Cranberry Lake (Harrison)	Windfall Lake (Foley)	Adults	Largemouth bass	61
1979	Galla Lake (Freeman)	Windfall Lake (Foley)	Adults	Largemouth bass	21
1979	Whalley Lake (Chapman)	Private hatchery	Adults	Largemouth bass	99
1979	Wilson Lake (Monteith)	Cole Lake (Carling)	Adults	Largemouth bass	49
Early 1980s	Eastern Lake (Severn)	Matchadash Lake (Severn)	Unknown	Largemouth bass	Unknown
Mid 1980s-90s	Welland River (Wellandport area)	Unknown (Unknown)	Adults	Largemouth bass	100-200/year
1981 or 1984	Mary Lake (St. Johns)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown

Year	Recipient Waterbody (Township(s))	Donor Waterbody (Township(s))	Life Stage	Species Stocked	Number Stocked
1981	Fume Lake (Christie)	Storm Lake (Christie)	Adults	Largemouth bass	56
1981	Fume Lake (Christie)	Martin Lake (Christie)	Adults	Largemouth bass	9
1981	Horn Lake (Monteith)	Axe Lake (McMurrich)	Adults	Largemouth bass	181
1981	Horn Lake (Monteith)	Mead Lake (Monteith)	Adults	Largemouth bass	19
1981	Little Manitouwaba Lake (Christie)	Axe Lake (McMurrich)	Adults	Largemouth bass	94
1981	Mosquitoe Lake (Freeman)	Boyne River Lake (Foley)	Adults	Largemouth bass	25
1981	Mosquitoe Lake (Freeman)	Cole Lake (Carling)	Adults	Largemouth bass	20
1981	Nine Mile Lake (Ferguson)	Axe Lake (McMurrich)	Adults	Largemouth bass	141
1981	Nine Mile Lake (Ferguson)	Manitouwaba Lake (Christie)	Adults	Largemouth bass	16
1981	Shanty Lake (McKellar)	Axe Lake (McMurrich)	Adults	Largemouth bass	99
1981	Wilcox Lake (Conger)	Axe Lake (McMurrich)	Adults	Largemouth bass	59
1982	Carruthers Lake (Christie)	Axe Lake (McMurrich)	Catchables	Largemouth bass	25
1982	Crawford Lake (Croft)	Axe Lake (McMurrich)	Catchables	Largemouth bass	100
1982	Fletchers Lake (Hanna)	Middleton Lake (Flavelle)	Fry	Smallmouth bass	4,500
1982	Gilbank Lake (Humphrey)	Axe Lake (McMurrich)	Catchables	Largemouth bass	51

Year	Recipient Waterbody (Township(s))	Donor Waterbody (Township(s))	Life Stage	Species Stocked	Number Stocked
1982	Love Lake (Croft)	Axe Lake (McMurrich)	Catchables	Largemouth bass	25
1982	McLean Lake (Christie)	Axe Lake (McMurrich)	Catchables	Largemouth bass	36
1982	Plate Lake (Foley)	Axe Lake (McMurrich)	Catchables	Largemouth bass	25
1982	Santa Lake (Christie)	Axe Lake (McMurrich)	Catchables	Largemouth bass	35
1982	Santa Lake (Christie)	Martin Lake (Christie)	Catchables	Largemouth bass	45
1982	Tabor Lake (McMurrich)	Axe Lake (McMurrich)	Catchables	Largemouth bass	54
1982	Tatai Lake (Foley)	Yarrow Lake (Foley)	Catchables	Largemouth bass	30
1983	Clear/Gravel Lake (O'Brien)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	112
1983	St. Amand Lake (Neely & Burritt)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	138
1984	Clear/Gravel Lake (O'Brien)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	87
1984	Cooper Lake (Oscar)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	102
1984	Irvine Creek(Nichol)	Grand River (Dunn & Sherbrooke)	Yearlings	Smallmouth bass	approx. 34
1984	Star Lake (Keefer)	Unknown (Unknown)	Fry & Adults	Smallmouth bass	Unknown
1985	Bay Lake (Pierce)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	200

Year	Recipient Waterbody (Township(s))	Donor Waterbody (Township(s))	Life Stage	Species Stocked	Number Stocked
1985	Lake #4 (Noble)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	140
1985	Raft Lake (McCowan)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	50
1985	Silver Queen Lake (Leitch)	Otisse (Powell)	Adults	Smallmouth bass	145
1986	Cooper Lake (Oscar)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	312
1986	Hazen Lake (Hazen)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	600
1986	Mudswamp Lake (Sabine)	Devine (Lake of Bays)	Unknown	Largemouth bass	19
1986	Pooles Lake (Leitch)	Otisse (Powell)	Adults	Smallmouth bass	150
1986	Racine Lake (Racine & D'Arcy)	Otisse (Powell)	Adults	Smallmouth bass	56
1986	Racine Lake (Racine & D'Arcy)	Windermere (35, 36 & 37)	Adults	Smallmouth bass	24
1986	Roys Lake (Sabine)	Devine (Lake of Bays)	Unknown	Largemouth bass	51
1987	Bear Lake (Monteith)	Axe (McMurrich)	Catchables	Largemouth bass	146
1987	Gooseneck Lake (Burton)	Axe (McMurrich)	Catchables	Largemouth bass	169
1987	Lake #26 (Noble)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	260

Year	Recipient Waterbody (Township(s))	Donor Waterbody (Township(s))	Life Stage	Species Stocked	Number Stocked
1987	Lake #4 (Noble)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	214
1987	Lake #62 (Beaton)	South Inverness Lake (Inverness)	Adults	Smallmouth bass	250
1987	Lamotte Lake (Noble)	South Inverness Lake (Inverness)	Adults	Smallmouth bass	349
1987	Racine Lake (Racine & D'Arcy)	Middleton Lake (Flavelle)	Fry	Smallmouth bass	700
1987	Rainy Lake (Ryerson)	Axe Lake (McMurrich)	Catchables	Largemouth bass	163
1987	Remi Lake (Gurney & Fauquier)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	538
1987	Sugar Lake (Christie)	Axe Lake (McMurrich)	Catchables	Largemouth bass	84
1987	Tony Lake (de Gaulle)	South Inverness Lake (Inverness)	Adults	Smallmouth bass	274
1988	Alder Lake (Wilmot)	Guelph Reservoir (Guelph and Eramosa)	Yearlings	Largemouth bass	53
1988	Avery Lake (Avery)	Jackfish Lake (Satterly)	Adults	Smallmouth bass	25
1988	Big Star Lake (Keefer)	South Inverness Lake (Inverness)	Adults	Smallmouth bass	200
1988	Blackwater Lake (Christie)	Axe Lake (McMurrich)	Catchables	Largemouth bass	123
1988	Clam Lake (Chester)	South Inverness Lake (Inverness)	Adults	Smallmouth bass	250
1988	Clear Lake (Burton)	Axe Lake (McMurrich)	Catchables	Largemouth bass	101

Year	Recipient Waterbody (Township(s))	Donor Waterbody (Township(s))	Life Stage	Species Stocked	Number Stocked
1988	Deer Lake (Lount)	Axe Lake (McMurrich)	Catchables	Largemouth bass	211
1988	Geoffrion Lake (Groves)	South Inverness Lake (Inverness)	Adults	Smallmouth bass	250
1988	Gillies Lake (Tisdale)	South Inverness Lake (Inverness)	Adults	Smallmouth bass	150
1988	Gordon Lake (McKenzie)	Axe Lake (McMurrich)	Catchables	Largemouth bass	40
1988	Lipsett Lake (Lipsett)	South Inverness Lake (Inverness)	Adults	Smallmouth bass	200
1988	Little Star Lake (Keefer)	South Inverness Lake (Inverness)	Adults	Smallmouth bass	200
1988	Lord Lake (McEvay)	Holmes Lake (Flavelle & Holmes)	Fry	Smallmouth bass	7,000
1988	Mooreland Lake (McCann)	Holmes Lake (Flavelle & Holmes)	Fry	Smallmouth bass	8,000
1988	Pronger Lake (Zealand)	Jackfish Lake (Satterly)	Adults	Smallmouth bass	6
1988	Remi Lake (Gurney & Fauquier)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	502
1988	Tomwool Lake (Lee)	Holmes Lake (Flavelle & Holmes)	Fry	Smallmouth bass	9,000
1988	Verona Lake (Lee)	Holmes Lake (Flavelle & Holmes)	Fry	Smallmouth bass	7,000
1989	Cornice Lake (Wigham & Silk)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	200
1989	Crawfish Lake (Duff)	South Inverness Lake (Inverness)	Adults	Smallmouth bass	180
1989	Drizzle Lake (Sabine)	Serpentine Lake (Anstruther)	Adults	Largemouth bass	50

Year	Recipient Waterbody (Township(s))	Donor Waterbody (Township(s))	Life Stage	Species Stocked	Number Stocked
1989	Drizzle Lake (Sabine)	L'Amable Lake (Sabine)	Adults	Largemouth bass	8
1989	Hardiman Lake (Hardiman)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	200
1989	Kyushk Lake (Ossin & Lougheed)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	200
1990	Grand River (Dunn & Sherbrooke)	Chicopee Reservoir (City of Kitchener)	Unknown	Largemouth bass	Unknown
1991	Lac Des Iles (Williamson)	Clear/Gravel Lake (O'Brien)	Adults	Smallmouth bass	7
1991	Lac Des Iles (Williamson)	Clear/Gravel Lake (O'Brien)	Fingerlings	Smallmouth bass	104
1993	Lac Des Iles (Williamson)	Clear/Gravel Lake (O'Brien)	Fingerlings	Smallmouth bass	497
1993	Rosamond Lake (Mafeking & Wauchope)	Brownie Lake (Smellie)	Adults	Smallmouth bass	35
1993	Rosamond Lake (Mafeking & Wauchope)	Ely Lake (Langton)	Adults	Smallmouth bass	46
pre-1994	Elkhorn Lake (Milner & Keith)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
pre-1994	Margueratt Lake (Milner)	Unknown (Unknown)	Unknown	Smallmouth bass	Unknown
1994	Knob Lake (Rugby)	Centrefire Lake (McIlraith)	Adults	Smallmouth bass	65
1994	Rosamond Lake (Mafeking & Wauchope)	Ely Lake (Langton)	Adults	Smallmouth bass	20
1996	12-F-06 (Reaume)	Elephant Lake/ Friday Lake (Miramichi/Gillies Limit)	Adults	Smallmouth bass	180

Year	Recipient Waterbody (Township(s))	Donor Waterbody (Township(s))	Life Stage	Species Stocked	Number Stocked
1996	12-F-12 (Reaume)	Elephant Lake / Friday Lake (Miramichi/Gillies Limit)	Adults	Smallmouth bass	180
1996	Emerald Lake (Duff)	Elephant Lake/ Friday Lake (Miramichi/Gillies Limit)	Adults	Smallmouth bass	180
1996	Paddy Lake (Duff)	Friday Lake (Gillies Limit)	Adults	Smallmouth bass	180
1996	Verte Lake (Duff)	Elephant Lake/ Friday Lake (Miramichi/Gillies Limit)	Adults	Smallmouth bass	180
1997	Lake Niapenco (Glanbrook)	Unknown (Unknown)	Adults	Largemouth bass	200
1997	5 kettle lakes(Unknown)	Elephanthead Lake (Connaught & Miramachi)	Adults	Smallmouth bass	350 in total
1998	5 kettle lakes (Unknown)	Friday Lake (Best and Gillies)	Adults	Smallmouth bass	600 in total
1999	Lake Obabik (Le Roche & Belfast)	Friday Lake (Best and Gillies)	Juveniles	Smallmouth bass	240
1999	Newberry Lake (Stimson)	Elkhorn Lake /Otisse Lake (Milner/Powell)	Adults	Smallmouth bass	150
1999	Pallet Lake (Duff)	Elkhorn Lake /Otisse Lake (Milner/Powell)	Adults	Smallmouth bass	150
1999	Sommerville Lake (Clute)	Elkhorn Lake /Otisse Lake (Milner/Powell)	Adults	Smallmouth bass	150
1999	Star Lake (Alexandra)	Elkhorn Lake /Otisse Lake (Milner/Powell)	Adults	Smallmouth bass	150
1999	Tom Lake (St. John)	Elkhorn Lake /Otisse Lake (Milner/Powell)	Adults	Smallmouth bass	150

APPENDIX 4. A summary of post-stocking survival rates of largemouth bass reported from various North American waters.

Waterbody	Life Stage Stocked	Time from Release	Survival Rate (%)	Reference
Aquaria/Pools				
Large Pools (4) (North Carolina)	Fingerlings	Approx. 1 year	1.0-20.0%	Pardue and Hester (1966)
Small Pools (5) (North Carolina)	Fingerlings	Approx. 1 year	1.4-29.0%	Pardue and Hester (1966)
Test Aquaria (3) (Ohio)	Fingerlings	35 weeks	34.9% (average)	Fullerton et al. (2000)
Test Aquaria (3) (Ohio)	Fingerlings	35 weeks	61.1% (average)	Fullerton et al. (2000)
Test Aquaria (3) (Ohio)	Fingerlings	35 weeks	59.4% (average)	Fullerton et al. (2000)
Lakes				
Boomer Lake (Oklahoma)	Fingerlings (Florida and Northern)	225 days	0.13 and 2.9%	Rieger and Summerfelt (1976)
Boomer Lake (Oklahoma)	Fingerlings (Florida and Northern)	191 days	13.10 and 12.4%	Rieger and Summerfelt (1976)
Lake 4 (Florida)	Adults	12-30 months	4-11%	Porak et al. (1994)
Lake Gladewater Nursery Pond (Texas)	Fingerlings	3-4 months	20.9%	Ryan et al. (1996)
Unnamed Lakes (Florida)	Fingerlings and Subadults	One year	< 1%-34%	Porak et al. (2000)
Reservoirs				
16 Reservoirs (Texas)	Fry and Fingerlings	24 hours	96%	Pitman and Gutreuter (1993)
O. H. Ivie Reservoir (Texas)	Fingerlings	24 hours	100%	Buckmeier and Betsill (2000)
Unnamed Reservoirs (13) (Oklahoma)	Fingerlings	12 months	25% (average)	Gilliland (1994)
Ponds				
A. E. Wood State Hatchery ponds (8) (Texas)	Fingerlings	18 months	47.1-83.8%	Brown (1952)

Waterbody	Life Stage Stocked	Time from Release	Survival Rate (%)	Reference
Ponds Cont'd				
Ashland Ponds (6) (Missouri)	Fingerlings (Florida and northern)	8 months	4% and 65%	Johnson (1975)
Gay's Pond (North Carolina)	Fingerlings	369 days	34.5%	Pardue and Hester (1966)
Knott's Pond (North Carolina)	Fingerlings	344 days	13.6%	Pardue and Hester (1966)
Lake Conroe Nursery Pond (Texas)	Fingerlings	3-4 months	15.6%	Ryan et al. (1996)
Pond 17 (Oklahoma)	Fry	6 months	75%	Aldrich (1943)
Pond 17 (Oklahoma)	Fry	6 months	77.5%	Aldrich (1943)
Unnamed Ponds (Alabama)	Fry	1 year	85-90%	Smith and Swingle (1942)
Unnamed Ponds (Alabama)	Fingerlings	1 year	80%	Smith and Swingle (1942)
Unnamed Ponds (Alabama)	Fingerlings	6 months	74.4%	Swingle (1951)
Unnamed Ponds (Alabama)	Fingerlings	1.5 years	54%	Swingle (1951)
Unnamed Ponds (2) (Alabama)	Unknown	2 years	40 and 50%	Snow (1975)
Unnamed Ponds (8) (Indiana)	Fingerlings	10 months	78.8% (average)	Janisch (1976)
Unnamed Ponds (2) (Iowa)	Fingerlings	6 months	60 and 56%	Mitzner and Hill (1976$_{a}$)
Unnamed Pond (Iowa)	Fingerlings	6 months	46%	Mitzner and Hill (1976$_{a}$)
Unnamed Ponds (10) (Mississippi)	Fingerlings	5 months	10-97%	Miranda and Hubbard (1994)
Unnamed Ponds (10) (Mississippi)	Fingerlings	5 months	77-93%	Miranda and Hubbard (1994)
Unnamed Pond (New York)	Fry	14 months	50%	Fieldhouse (1971)

Waterbody	Life Stage Stocked	Time from Release	Survival Rate (%)	Reference
Ponds Cont'd				
Unnamed Ponds (10) (Ontario)	Fingerlings	1 year	55% (average)	Johnson and MacCrimmon (1967)
Unnamed Ponds (10) (Ontario)	Fingerlings	2 years	42% (average)	Johnson and MacCrimmon (1967)
Unnamed Ponds (10) (Ontario)	Fingerlings	1 year	66% (average)	Johnson and MacCrimmon (1967)
Unnamed Ponds (4) (South Dakota)	Fingerlings	First Year Survival (using scale estimates)	75.5%	Stone and Modde (1982)
Unnamed Ponds (4) (South Dakota)	Fingerlings	First Year Survival (using scale estimates)	68.7%	Stone and Modde (1982)
Unnamed Ponds (4) (South Dakota)	Fingerlings	First Year Survival (using scale estimates)	7.6%	Stone and Modde (1982)
Unnamed Ponds (4) (South Dakota)	Fingerlings	First Year Survival (using scale estimates)	49.3%	Stone and Modde (1982)
Unnamed Ponds (Wisconsin)	Adults	Unknown	49.5%	Mraz and Cooper (1957)

APPENDIX 5. A summary of post-stocking survival rates of smallmouth bass reported from various North American waters.

Waterbody	Life Stage Stocked	Time from Release	Survival Rate (%)	Reference
Lakes				
A.Y. Jackson Lake (Ontario)	Adults	24 hours	100%	Snucins and Shuter (1991)
Acid Lake (Ontario)	Adults	24 hours	38%	Snucins and Shuter (1991)
Partridge Lake (Ontario)	Adults	24 hours	80%	Snucins and Shuter (1991)
Terry Lake (Ontario)	Adults	24 hours	100%	Snucins and Shuter (1991)
Ponds				
Test Ponds (8) (Missouri)	Fingerlings	Approx. 1 year	2-62%	Coble (1971)
Reservoirs				
2 Reservoirs (Texas)	Fry and Fingerlings	24 hours	98.7%	Pitman and Gutreuter (1993)

APPENDIX 6. Contributions of stocked largemouth bass to selected recreational fisheries in North America.

Waterbody	Life Stage Stocked	Time from Release	Survival Rate (%)	Reference
Lakes				
2 Lakes (North Carolina)	Legal Length	38% and 10%	1 fishing season	King (1942)
Nassau Lake (New York)	Yearlings	0.5% and 0.2% of number stocked	Approx. 10 months	Fieldhouse (1971)
Taylorsville Lake (Kentucky)	Fingerlings	11.6% of legal harvest	5 years	Buynak and Mitchell (1999)
Ponds				
Select Unnamed Ponds (Massachusetts)	Adults	28% of number stocked	3 years	Stroud (1955)
Unnamed Pond (Alabama)	Adults and Fingerlings	1.2% of number stocked	5 years	Swingle and Smith (1943)
Unnamed Ponds (4) (Oklahoma)	1 and 2 year olds	91.5% Northern subspecies; 58.3% Florida subspecies; of number stocked	6 days of fishing over 2 years	Rieger et al. (1978)
Unnamed Ponds (4) (Oklahoma)	1 and 2 year olds	22.0% Northern subspecies; 0.0% Florida subspecies; of number stocked	1 month	Rieger et al. (1978)

APPENDIX 7. Contributions of stocked smallmouth bass to selectedrecreational fisheries in North America.

Waterbody	Life Stage Stocked	Time from Release	Survival Rate (%)	Reference
Lakes				
Cache Lake (Ontario)	Adults	17% of number stocked	Unknown	Anonymous (1959)
Cache Lake (Ontario)	Fingerlings	10.5% of number stocked	1 fishing season	Baldwin (1947$_a$)
Claytor Lake (Virginia)	Sub-catchables	16% of number stocked 40% of number stocked	after 4 years after 5 years	Rosebery (1950)
Herrington Lake (Kentucky)	Fry and Fingerlings	1.3% of total smallmouth bass harvested	4 years	Buynak (1999)
Named Lakes (Texas)	Adult	7-54% of number stocked	18 months	Rutledge and Gregg (1989)
Ponds				
Brettun's Pond (Maine)	Unknown	19.7% of number stocked	1 year	Boucher (1993)
Unnamed Ponds (Massachusetts)	Adults	61% of number stocked	3 years	Stroud (1955)
River				
Big Piney River (Missouri)	Fingerlings	2% of number stocked	5 years	Fleener et al. (1974)

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